AGRICULTURAL ENGINEERING

NOVEMBER • 1949

A.S.A.E. Winter Meeting • Chicago, Ill., December 19-21, 1949

ASAE

THE JOURNAL OF THE AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

AGRICULTURAL ENGINEERING

Established 1920

CONTENTS FOR NOVEMBER, 1949

Vol. 30, No. 11

AGRICULTURAL ENGINEERING is indexed regularly by Engineering Index, Inc.

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AGRICULTURAL ENGINEERING is owned, edited, and published monthly by the American Society of Agricultural Engineers. The editorial, subscription and advertising departments are at the executive office of the Society, Saint Joseph, Michigan.

SUBSCRIPTION PRICE: $4.00 a year, plus an extra postage charge to all countries to which the second-class postage rate does not apply; to A.S.A.E. members anywhere, $2.00 a year. Single copies (current), 40 cents each.

POST OFFICE ENTRY: Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921.

AGRICULTURAL ENGINEERING is a member of the Audit Bureau of Circulations.

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EDITORIAL

Engineers Sell Ideas

AN ESTEEMED veteran member of the American Society of Agricultural Engineers has recently reminded us of the extent to which engineers are engaged in selling "ideas".

Not discouraged by the warning attributed to C. F. Kettering, that it takes at least five years to sell a new idea, engineers pitch in and keep at it, and get some new ideas sold. They are great "spreaders of information" which leads to intelligent action.

Probably the best door opener for engineers is a reputation for selling sound ideas for what they are worth.

A good engineer has considerable of the scientist's zeal for accuracy, for quantitative values, for the discreetly qualified statement, for recognition of limitations.

Before trying to sell an idea to the world or to one other person, he will make himself the toughest, hardest customer to convince that he is likely to encounter. He will put the idea to every conceivable test and learn its weaknesses and limitations as well as its strong points.

Then he will propound the idea only as sound and applicable for certain purposes under specific conditions and within clearly defined limits. He offers no medicine-show miracle tonic good for 101 ailments of man or beast.

Our world is full of useful equipment, materials, structures, and methods resulting from ideas sold by engineers, first to themselves, and then to others, on the basis of merit for specific applications.

The people who buy and sell on a less factual basis contribute mightily to the rubbish piles and scrap heaps of civilization.

Engineering capacity to be simultaneously open-minded and objectively critical concerning new ideas is an important factor in the progress of agricultural engineering. It provides an approach to mutual understanding and cooperation on a basis of quantitative values. It helps agricultural engineers to sell new ideas to each other, and to farmers, manufacturers, dealers, agricultural scientists, and other engineers. It is a capacity to be studiously developed by young agricultural engineers.

Agricultural Research and Production Efficiency

IN A HIGHLY critical paper published this past summer, Dr. W. Gordon Whaley has presented some thoughts well worthy of the attention of agricultural engineers. It appeared in the July 22, 1949 issue of "Science," the weekly journal of the American Association for the Advancement of Science (Washington 5, D. C.).

Many will readily agree in principle with his proposition that "From any long range view, further lifting of the world standard of living can only follow increases in agricultural efficiency. In fact, because of increasing population pressures, even maintenance of the present standard demands a very considerable increase in this efficiency."

There will be less agreement on his treatment of agricultural research and research administration as means of showing the way to increased agricultural efficiency. The question is touchy because so many people and so many conflicting beliefs and immediate interests are involved.

Even the scientists who conduct the research are far from complete objective agreement on the outline for a coordinated program of research offering the greatest promise of increasing agricultural efficiency.

Some clarification of the issue may result from consideration of a further proposition advanced by Dr. Whaley: "We are now at a point where major agricultural advances can come only after we have gained much more knowledge concerning the fundamental biology of our crop plants."

It is apparent that our agriculture and civilization could never have reached its present place without such foundations as Mendel's law of heredity or Newton's laws of motion. It seems reasonable that further foundation knowledge of biology and engineering might readily show the way to new long steps in increasing agricultural efficiency.

So far as agricultural engineering is concerned, we feel safe in saying that one of the greatest and most commonly encountered obstacles to progress is the limited available knowledge of the biological subjects to which this engineering is applied. We need more explicit, specific, accurate, quantitative knowledge of the biological factors in agriculture to be influenced by the physical factors of engineering. We need to know more about the biological functions of production in order to implement them more effectively.

Agricultural engineers, as implementers of nature, are in a particularly favorable position, we believe, to interpret to biological scientists, research administrators, and the supporting public, the need and practical significance of additional fundamental knowledge in biology.

Dr. Whaley has more company than he may realize, in his misery over the rate of progress in agricultural research, and the obstacles encountered. He presents the dark side of the picture. The bright side is that all true scientists and engineers are with him in being dissatisfied with the limitations of present knowledge and impatient with the rate at which new knowledge is produced. Their dissatisfaction and impatience are the vitamins of progress.

Costs and Prices

APPARENTLY many people are still thinking of low cost food and high farm income as directly conflicting interests. There is evident concern over natural and artificial price levels at which food costs and farm income might reach an equitable balance.

It is readily evident that, in the range of price above delivered cost, interests of buyer and seller are directly competitive. On any individual transaction, a price change which is a direct gain to one is a corresponding loss to the other.

This seems to blind a lot of people to the mutual interest of buyer and seller in lower costs. They overlook the gain which can be split between higher margins and wider markets for the seller, and lower prices and increased use for the buyer, when costs are lowered.

In fact, few people not trained in engineering, cost accounting, or business administration think of costs as something which can be lowered. A lot of thinking about the problems of agriculture has been based on assumed fixed levels of cost involved in the production of various farm commodities.

Actually it is a matter of record that farm costs per unit of marketed product vary through extremely wide ranges, from season to season, year to year, area to area, farm to farm, and operation to operation. And there is no indication that even the most efficient farmers have come anywhere near to reaching an irreducible minimum of costs per unit of production.

Engineers and big business generally, some small business and some farmers have shown a keen awareness of possibilities for reducing costs, and gains to be made thereby.

The important thing to remember about costs is that in final analysis they are mostly costs in human life, whether expressed in man-hours, in dollar values created by man-hours, in the astronomical figures of our economic waste, or in prices which mean privation. And they can be reduced.

When more people can be taught to take a realistic view of costs, and the fact that they can be lowered, some of the current economic problems of agriculture and other industries will be solved. Less effort will be wasted on juggling prices and more will be applied to the cost-cutting means by which price problems can be reduced.

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VOL. 30 NOVEMBER, 1949 No. 11

A Continuous Spray-Type Seed Treater

By Robert A. Kepner and L. D. Leach

MEMBER A.S.A.E.

SEED treatment offers an inexpensive and relatively simple method of controlling certain seed-borne diseases and of protecting germinating seeds against certain types of soil-borne organisms. In recent years most seeds have been treated by dusting the fungicides upon the seeds in either batch or continuous treaters. This method, however, has not been entirely satisfactory, chiefly because the dusts may be offensive to the operator during treating or to the grower during planting. Some of the fungicides are poisonous when ingested, others may cause severe skin irritation, particularly upon susceptible individuals, while still others are offensive when inhaled.

The introduction of the slurry treater and the formulation of wettable fungicides for use in it represents a real advance in dust elimination. With certain rough or absorbent seeds, however, there is some question as to the uniformity of fungicide distribution by this method.

Spraying the seed with a suspension of a wettable fungicide or with a soluble fungicide combines the advantages of dust elimination and uniform coverage of all types of seeds.

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

ROBERT A. KEPNER and L. D. LEACH are, respectively, assistant agricultural engineer and plant pathologist in the agricultural experiment station, University of California, Davis.

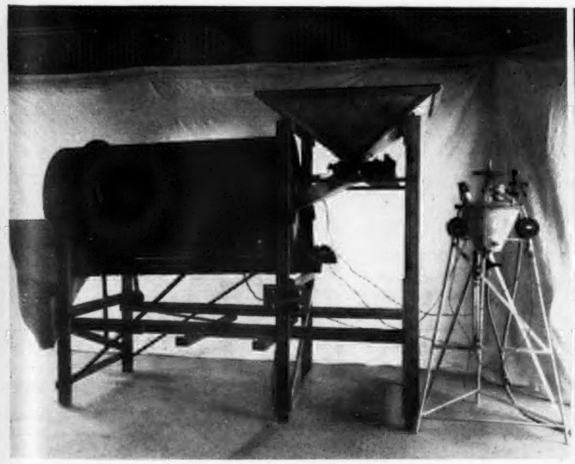
EDITOR'S NOTE: This work covers an original investigation aimed at overcoming many of the difficulties encountered in treating seeds of various types. Many of the new fungicides are quite harmful to the operators when applied in the dust form. Dr. Leach proposed this new system after some preliminary laboratory trials and has worked very closely with Mr. Kepner on its development. The unit has already passed through the laboratory and development stage. A pilot model of a design suitable for commercial production has been completed and is now being installed in a plant where sugar beet seed is to be treated commercially with it. The chief advantage over slurry treatment is greater uniformity of coverage on rough absorbent seeds such as sugar beet seed.

Numerous comparisons [1,2]* have shown that, with uniform coverage, spray applications of fungicides give protection equal or superior to that from dust treatments. A semiautomatic batch treater for spray application has been developed by Armer[3] of the Spreckels Sugar Co. Two of the machines have been used during the past two seasons to treat over a million pounds of beet seed.

Despite the advances already made, there still remains a demand for a continuous seed treater of high capacity that will eliminate dustiness in all phases of the process and that will apply soluble or wettable fungicides or insecticides to all types of seeds in a uniform manner. Preliminary trials with laboratory models suggested that this objective could be most nearly attained by the application of a spray to the seed while it passed through a revolving cylinder of sufficient diameter to allow good dispersion of the spray. A full-scale model was then built with all the elements necessary for the treating process, and with adjustable features for the determination of optimum conditions of operation.

Tests with the experimental unit have been completed, and the results are presented in this paper. The performance of the unit was evaluated with respect to mechanical difficulties, uniformity of seed coverage, and the degree of protection afforded by fungicidal applications. In most of the tests, a green dye was applied with the seed-treating material so that uniformity of coverage could be checked visually. Plantings were made in sterile soil or sand to check for injurious effects and in infested soil to measure protection. Preliminary developmental work was carried out with decorticated sugar beet seed because its rough absorbent outer surface makes uniform distribution of a liquid more difficult than on smooth-coated seeds. Subsequent tests were made with milo (grain sorghum) and with lima beans in order to include a considerable range of seed size, shape, and surface condition.

* Superscript numbers refer to the appended bibliography.



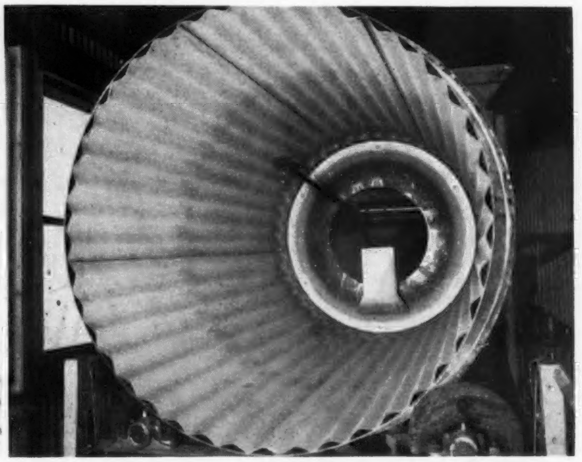


Fig. 1 (*Left*) Experimental seed treater. The seed hopper is above the right end of rotary drum with seed meter attached to bottom of hopper. Pressurized tank is in right foreground. Glass column in front of and below tank is for volumetric flow-rate checks. The two pressure gages indicate pressures at the two ends of the 3/16-in (o.d.) copper tubing line from tank to nozzle. Drum outlet spout and elevators used in test are not shown; a ¾-hp-drive motor is behind the drum • Fig. 2 (*Right*) Interior view of drum taken from outlet end. Note corrugated liner and nozzle on end of arm. Darkened area on liner indicates spray zone, which is about 3-ft long

After tests had shown that seeds could be uniformly and effectively treated in the experimental unit, a commercial model was designed embodying the improvements suggested by the preliminary trials and with both ends closed for greater protection of operators. One such unit is now being built for operation and testing in a plant where seed is treated commercially.

Description and Operation. A side view of the experimental unit is shown in Fig. 1. During the tests, two cup-type elevators (not shown) were used to recirculate seed into the hopper when the spray was not being used, or to put sprayed seed into bags or into a weighing can on scales. In the operation of the treater, seed is metered into one end of the rotating drum and is spilled out of the opposite end after being treated. On the inside of the drum is a liner made from sheets of corrugated aluminum roofing (Fig. 2). As the drum rotates, the corrugations carry seed up from the bottom, spreading it over a band about 1 to 2 in thick, extending from the lowest part of the drum up through an angle of 80 to 100 deg (Fig. 3). The spray material is directed onto this band of seed by a fan-type weed nozzle mounted inside the drum about 2 ft from the inlet end, as shown in Fig. 2. The drum was made 3 ft in diameter so that the nozzle could be placed far enough away from the seed surface to allow good dispersion of the spray before striking the seed. The 6-ft length of the drum accommodates a standard size of corrugated roofing. The corrugated liner is self-cleaning because of the absence of sharp corners, the flatness of the corrugations with respect to the drum, and the resultant scouring action of the seed.

In order to obtain a constant rate of application or dosage of the treating material, it is necessary that the seed be accurately metered into the drum at a constant rate and that the nozzle flow-rate be constant. Metering of the seed is accomplished by means of a 4½-in-diameter vaned wheel, which maintains a practically constant volumetric rate at a given rpm. Fig. 4 shows a cross section of this seed meter. The possibility of crushing the larger seeds, such as large lima beans, has been virtually eliminated by having a minimum clearance of about 7/16 in between the housing and the rotor vanes. The experimental seed meter is 14- in long and was operated at speeds from 9 to 33 rpm. Volumetric rates per rpm (or displacement) for decorticated sugar beet seed, milo, and baby lima beans were all within ± 5 per cent of an over-all average.

The spray system is the most involved part of a spray-type seed treater and is the part mostly likely to give trouble in field use, primarily because most of the presently used treating materials are insoluble powders which must be kept in suspension (usually in water) during application. Materials used during these tests, either for actual treating runs or for merely testing the spray system, were:

(a) Phygon paste — 55 per cent dichloro napthoquinone — a "micronized" formulation manufactured by the United States Rubber Co. (Stated particle size, "in the order of 3 to 5 microns").

(b) Spergon SL — tetrachloro-para-benziquinone — a wettable powder manufactured by the United States Rubber Co.

(c) Isotox seed treater — 75 per cent lindane (pure gamma isomer of hexachlorocylohexane) — a wettable powder manufactured by the California Spray-Chemical Corp.

(d) Arasan S. F., finely ground — 75 per cent tetramethyl thiuramdisulphide — a wettable powder manufactured by E. I. du Pont de Nemours & Co.

In order to keep these insoluble materials in suspension, agitation is required in the supply tank and adequate velocities must be maintained in pipes. The suspended material tends to clog screens and nozzles and may permanently plug small pipes after a shutdown unless the system is flushed. Nozzles must be small because only a very low percentage of moisture can be applied to seeds (less than one per cent maximum on some seeds); yet they and the screens must be large enough to pass the suspended particles of treating material. With the exception of one lot of Isotox, which was much coarser than lots previously obtained, none of the materials used in these tests gave any serious clogging trouble when Spraying Systems Co. No. 80015 Teejet weed nozzles (rated at 0.15 gpm water at 40 psi) and 60-mesh screens were used. No. 8001 nozzles clogged only occasionally. Of the materials listed above, the Phygon paste gave the least trouble due to clogging, presumably because of its smaller particle size. Similar formulations of other materials will undoubtedly be forthcoming and will tend to minimize nozzle clogging troubles.

Another problem encountered in connection with the spray system is that of abrasion caused by the suspended particles. Some of the materials are so abrasive that a gear pump will wear out in a few days, and brass nozzles would have to be replaced after only a few hours of operation. In the first tests, a bronze gear pump was used in conjunction with an open supply tank having mechanical agitation. Because of the rapid wearing of this type of pump, and because no suitable type could be found, it was decided to use a pressurized supply tank with the agitator shaft entering from the top so that no wearing parts would be in contact with the suspension. The 5-gal pressurized tank used with the experimental machine is shown at the right in Fig. 1. The commercial treater will have a 25-gal tank, which will be sufficient

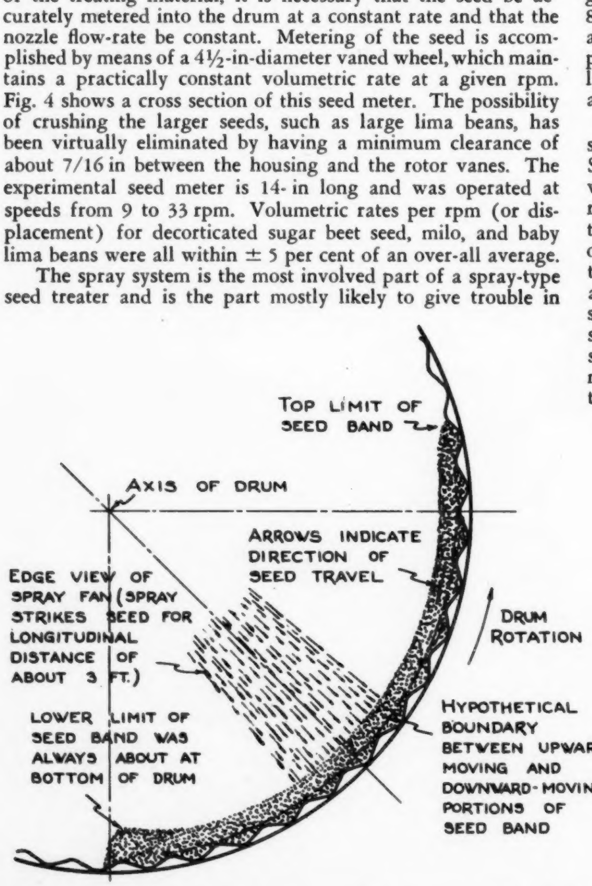


Fig. 3 Partial cross section of drum and liner showing seed band and general movement of seed

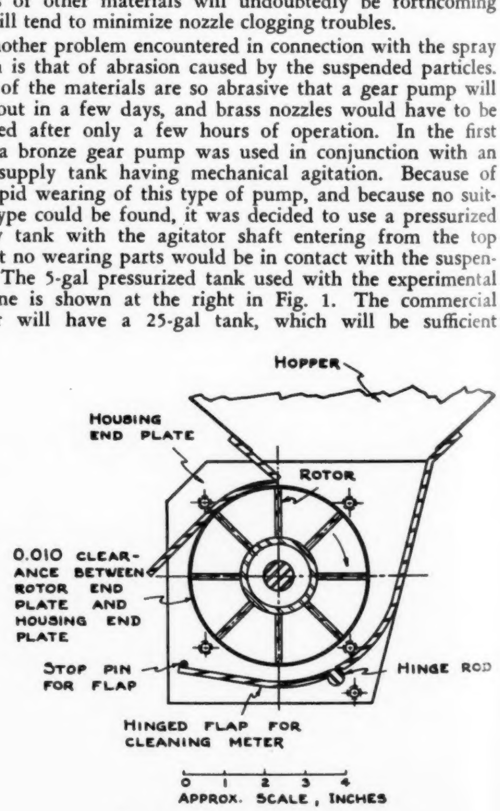


Fig. 4 Cross section of seed meter

capacity for about 3 hr of operation under usual conditions. The chief disadvantage of the pressurized tank is the inconvenience of refilling.

In order to get some idea of the seriousness of the nozzle erosion problem, 5-hr runs on several brass and stainless steel nozzles (at 25 psi) were made with Phygon paste and then with Arasan S. F. In general, erosion of a new nozzle was much more rapid during the first hour than after several hours of use, presumably because sharp edges were being worn away. For this reason, the first hour of the 5-hr period was omitted in determining the following figures for the average per cent flow-rate increase per hour:

	Brass	Stainless steel
Phygon paste (1 pt to 11 pt. water)	0.5 per cent per hr	0.25 per cent per hr
Arasan S.F. (0.9 lbs per gal water)	4.2 per cent per hr	0.6 per cent per hr

Note that the Phygon is apparently much less abrasive than the Arasan, presumably because of its "micronized" paste formulation (i.e., small particles). In field use, a total flow-rate increase of perhaps 10 per cent could readily be corrected by pressure adjustments. From the cost standpoint, nozzle tips could be replaced as often as every 10 to 20 hr. The stainless steel tips then appear to be satisfactory in regard to erosion. Hardened stainless steel tips are also available at moderate cost and might offer further reduction in rate of erosion.

Performance. Before making actual seed-treating runs on a particular kind of seed, short runs were made without applying any spray, in order to check for mechanical damage that might be attributed to the treater. Seed samples taken from the hopper and at the outlet end of the drum were compared as to per cent visible damage and per cent normal emergence in sterile sand or soil. Results for sugar beet seed, milo, and baby lima beans indicated that at a drum speed of 25 rpm, the treater (including seed meter) did not damage the seed. A similar run was made on Fordhook large lima beans, which were exceptionally brittle and susceptible to damage. As received for test, these beans had 44 per cent visible damage and only 59 per cent normal emergence. After they had been put through the treater at 25 rpm, normal emergence was 57.5 per cent, a change which is not statistically significant. At a drum speed of 18 to 20 rpm, which is adequate for treating beans, there should be a good margin of safety in regard to mechanical damage, even for brittle seeds such as these.

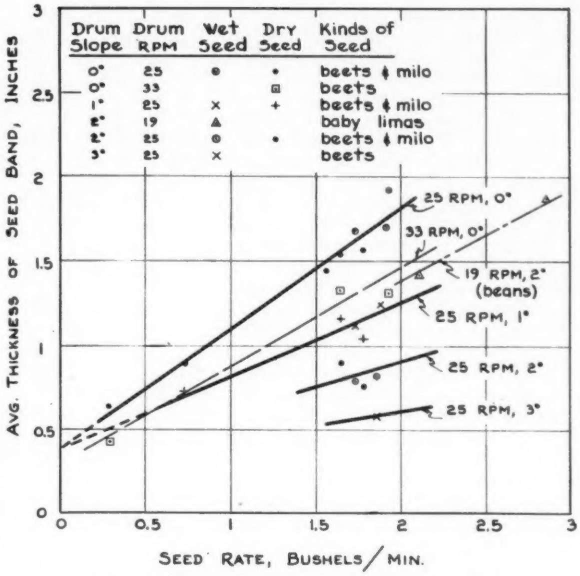


Fig. 5 Relation of seed-band thickness to seed rate

Runs during which the seed was actually treated were made with decorticated sugar beet seed, milo, and baby lima beans. The available quantity of the Fordhook large lima beans used for mechanical-damage checks was insufficient to permit any treating runs. Table 1 indicates the operating conditions for each run. The maximum drum speed used was about 25 rpm, because higher speeds carried the seed so far up that some of it would "shower" down through the spray zone instead of sliding back down as part of the seed band, and because some of the seed would stick sufficiently to carry over the top with the drum. Nozzle pressures below 25 psi were not tried with such seeds as sugar beets, which are difficult to treat uniformly. However, pressures as low as 15 psi can be used when treating smooth-coated seeds such as beans, where redistribution from seed to seed contributes to uniformity and nozzle spray characteristics are not so important.

TABLE 1. OPERATING CONDITIONS AND UNIFORMITY OF APPLICATION

Run no.	Drum slope, deg below horizontal	Drum speed, rpm	Nozzle pressure psi	Nozzle rating number*	Seed rate, lb/min	Per cent moisture added	Per cent light-colored seeds
	U.S. 33 decorticated sugar beet seed (1/6 pt Phygon paste per 100 lb of seed)						
3	0	25.5	60	8001	54	2.0	15
7	0	24	25	80015	52	1.9	12
4	0	20	60	8001	54	2.0	17
5	1	25	60	8001	52	2.0	6
8	0	24	60	8001	81	2.0	35
9	0	24	60	8001	52	4.0	4
	U.S. 22 decorticated sugar beet seed (1/6 pt Phygon paste per 100 lb of seed)						
10	0	25	60	8001	54	2.0	13
11	1	25	60	8001	53	2.0	11
12	2	25	60	8001	52	2.0	5
13	3	25	60	8001	52	2.0	9
	No. 38 double dwarf milo (1/12 pt Phygon paste per 100 lbs of seed)						
16	0	25	60	8001	105	1.0	22
14	1	25	60	8001	105	1.0	12
18	1	25	28	80015	105	1.0	15
15	2	25	60	8001	105	1.0	1
17	2	25	28	80015	105	1.0	3
	No. 38 double dwarf milo, 1200-lb continuous run (1 1/3 oz Isotox per 100 lb of seed)						
19	1	25	28	80015	105	1.0	--
	No. 38 double dwarf milo, 1500-lb run (1 1/3 oz Isotox and 1/12 pt Phygon per 100 lb of seed)						
20	1	25	25	80015	104	0.9	--
	Wilbur baby lima beans (water and dye only)						
24	2	19	27	8001	135	0.50	0
25	2	19	25	8001	183	0.38	0
26	2	19	15	8001	183	0.28	0
	Wilbur baby lima beans, 2000-lb run (1.9 oz Spergon and 1.2 oz Isotox per 100 lb)						
27	2	18	25	80015	136	0.50	0

* Spraying Systems Co. Teejet flat fan weed nozzles were used. No. 8001 nozzle is rated 80-deg included angle, 0.10 gpm of water at 40 psi. No. 80015 nozzle is rated 80-deg 0.15 gpm of water at 40 psi.

NOTE: For each group of runs, an underlined number indicates a major difference from operating conditions of top run in group.

For all treating runs, an aniline dye, Victoria Green, was dissolved in water and applied at the rate of 1 part to 15,000 parts of seed along with the suspended treating materials. Sprayed seeds were then examined visually and sorted into light, medium, and heavily colored groups, using an arbitrary standard of division. The per cent of light-colored seeds is reported in Table 1 as a measure of non-uniformity of coverage. For example, with U. S. 33 sugar beet seed, run 8, at 81 lb of seed per min and 2 per cent moisture, showed 35 per cent light-colored seeds; whereas run 9, at 52 lb per min and 4 per cent moisture, showed only 4 per cent light-colored seeds. These tests led to the conclusion that, with sugar beet seed, the maximum

TABLE 2. SEED-BAND RELATIONS IN ROTATING DRUM

Run no.	Drum rpm (N)	Axis slope, deg below horiz.	Seed rate lb per min	Seed rate bu per min (B)	Width of seed band, deg about drum axis (θ)	Lb seed in drum during steady operation (M)	Calc. avg. thickness of seed band, in (D)	Estim. avg. thickness of downward moving portion, number of seeds	Calc. avg. no. of times a seed passes down thru spray zone (Z)
				U.S. 33 decorticated sugar beet seed (28.0 lb per bu)					
3	25.5	0	54.0	1.93	100	49	1.72	11	7.5
				U.S. 22 decorticated sugar beet seed (28.0 lb per bu)					
10	25	0	54.3	1.94	100	55.5	1.95	13	7.4
11	25	1	53.0	1.89	100	36	1.26	7	7.5
12	25	2	52.0	1.86	100	23.5	0.83	4	6.4
13	25	3	52.0	1.86	95	16	0.60	3	5.1
				No. 38 double dwarf milo (60.2 lb per bu)					
16	25	0	105	1.74	100	104	1.70	11	8.1
14	25	1	105	1.74	100	69	1.13	6	8.1
15	25	2	105	1.74	100	49	0.81	4	6.8
				Wilbur baby lima beans (64.0 lb per bu)					
24	19	2	135	2.11	80	74	1.43	8 (flat)	4.3
25	19	2	183	2.86	80	98	1.89	11 (flat)	3.2

ERRATUM: The symbol *d*, instead of *D*, is correct for heading of the eighth column of this table.

rate for satisfactory coverage was 50 to 55 lb per min, or about 3,000 to 3,300 lb per hr. Although under optimum conditions, a 2 per cent moisture application provided good coverage upon sugar beet seed, the use of 4 per cent moisture gave still greater uniformity. Moisture additions greater than 4 per cent are impractical because of excessive wetting of the sugar beet seed. Upon other kinds of seeds this limit may be still lower. For example, not more than one per cent can be applied to milo seed without excessive wetting, while one-half per cent is the maximum rate upon beans. Even lower moisture rates are desirable for beans if the required amount of materials can be suspended in the limited amount of liquid.

With both sugar beet seed (runs 10 to 13) and double dwarf milo (runs 14 to 18) it was found that a drum angle of 2 deg below horizontal provided the most uniform coverage. A possible explanation for these results may be found in Table 2, which is discussed later in this paper. In limited comparisons with beet and milo seeds, nozzle pressures of 25 to 28 psi appeared to give as uniform coverage as a pressure of 60 psi.

As a further test of the protection afforded by fungicides applied with the experimental treater, samples from a number of the runs were planted in greenhouse flats in soils infested by *Pythium ultimum*, in comparison with non-treated seeds and with dusted seeds. The degree of protection was measured by the emergence and survival of seedlings under conditions extremely favorable for both preemergence and postemergence damping-off. In nearly all cases, the spray-treated seeds produced stands significantly higher than non-treated seeds. Because of the limited extent of these trials and the normal variability in this type of test, most of the differences between runs of the spray treater are not statistically significant. However, with sugar beets, the runs that appeared most uniform in the color sorting tended to provide the highest degree of protection. With milo, there were no significant differences in protection between the different spray applications or dusting (runs 14 to 18), but all treated lots showed significantly better emergence than the non-treated seed. When milo seed infested with *Fusarium moniliforme* was given a spray treatment with Phygon paste following a spray application of 75 per cent lindane, (run 19) and was then planted in pasteurized soil, almost complete control of seed-borne root-rot infection was obtained.

Treated milo seed from run 20, planted in the field at the rate of 11 lb per acre, produced 9.4 seedlings per foot, whereas non-treated seed planted at the same rate produced only 2.12 seedlings per foot of row. This difference is due in part to the protection of germinating seed against seed decay, provided by the Phygon, and in part to the control of wireworms by the application of 75 per cent lindane to the seed, a method of control developed by Lange, Carlson, and Leach[4].

With small lima beans (run 27), emergence of sprayed, dusted, and non-treated seed appeared to be about the same in pasteurized soil. In infested soil sprayed seed produced stands lower than the dusted and higher than non-treated seeds, but the difference was not significant in either case. In field plantings, the sprayed and dusted seeds produced about equal stands, both considerably better than the non-treated seeds.

Analysis of Mixing Action in Drum. During some of the treating runs, the amount of seed in the drum was determined by stopping simultaneously the seed meter, drum, and spray, and then emptying the drum and weighing the seed removed. In these runs, the top limit of the seed band was estimated in degrees up from the bottom of the drum. The lower edge of the seed band was always at about the lowest part of the drum. Similar data were obtained for several preliminary runs during which no spray was applied. These data provide a basis for some analytical consideration of the processes involved within the drum and the effect of various operating conditions on uniformity of coverage.

The action of the corrugated liner in the rotating drum is such that one layer of seed is being carried upward by the corrugations, while a second layer in contact with the first one is moving downward as a result of gravity (Fig. 3). Spray from the nozzle strikes those seeds which are at or near the exposed inner surface of the downward-moving layer. If we neglect the effect of turbulence and intermixing between the two layers, it is evident that the probability of a particular seed's being hit by the spray would be a function of the thickness of the downward-moving layer, the size of the seeds, and the number of times a seed passes downward within the longitudinal limits of the spray zone.

The average total thickness of the seed band can readily be calculated by using equation [2] of the derivation presented later in this paper. Table 2 includes the results of these calculations for all treating runs in which the amount of seed in the drum was measured; it also contains pertinent operating conditions for these runs. The relations of average seed-band thickness to volumetric seed rate for several drum slopes and speeds are presented graphically in Fig. 5. Results for dry-seed runs were plotted in addition to those for treating runs. Although the seed in dry runs carried up on the drum only 80 to 90 per cent as high as in corresponding wet runs, the amount of seed in the drum was proportionately less. Hence, as indicated in Fig. 5, the thickness of the band appears to be nearly independent of surface moisture condition of the seed, within the limits of these tests. It is also evident that for a given volumetric seed rate, the kind of seed had little effect on the thickness of seed band. Increasing the drum slope below horizontal or increasing the drum rpm results in a thinner seed band at a given volumetric seed rate.

Although the points plotted in Fig. 5 are inadequate to establish definitely straight-line relationships, the top four curves can reasonably be represented by straight lines with intercepts at $\frac{1}{4}$ to $\frac{3}{8}$-in seed-band thickness. Since the corrugations were $\frac{1}{2}$-in high, the average thickness of the seed band within the zone of corrugations would be $\frac{1}{4}$ in. Thus the intercepts of the curves might logically represent the thickness of the upward-moving portion of the seed band.

For determining the number of times a seed passes down through the spray zone, a simple relation can be derived as follows:

Let N = drum speed, rpm
B = seed rate, bushels per minute
W = seed density, pounds per bushel
M = pounds of seed in drum during steady operation

L = length of drum, feet
Z = length of spray zone along surface of seed band, feet
θ = width of seed band, degrees about axis of drum
R = average radius of seed band, about axis of drum, feet
d = average thickness of seed band, inches
u = average thickness of layer carried up by drum, inches
t_1 = average time for seed to be carried up from bottom to top of seed band, minutes
t_2 = average time for seed to return to bottom of band
t = average total time per round trip = $(t_1 + t_2)$
T = average time for seed to pass longitudinally through spray zone
f = seed slip factor = (degrees drum rotation in time t_1) $\div \theta$
E = number of round trips up and down that seed makes within longitudinal limits of spray zone.

The total volume (cubic feet) of seed in the drum at any instant may be expressed in two ways and equated as follows, remembering that 1 bu = 1.245 cu ft.

$$1.245 \frac{M}{W} = 2\pi R \frac{\theta}{360} \times \frac{d}{12} \times L \qquad [1]$$

from which $$d = 856 \frac{M}{WLR\theta} \qquad [2]$$

The times required for seed to be carried up and down once are

$$t_1 = \frac{f\theta}{360N} \qquad [3]$$

and $$t_2 = t_1 \frac{d-u}{u} \qquad [4]$$

from which $$t = \frac{f\theta}{360N}\left(1 + \frac{d-u}{u}\right) = \frac{f\theta d}{360Nu} \qquad [5]$$

Substituting equation [2] for d in equation [5] gives

$$t = \frac{f\theta}{360Nu} \times \frac{856M}{WLR\theta} = 2.38 \frac{fM}{NuWLR} \qquad [6]$$

The time (minutes) that seed is within spray zone is

$$T = \frac{M}{BW} \times \frac{Z}{L} \qquad [7]$$

The average number of round trips of a seed within spray zone is

$$E = \frac{T}{t} = \frac{ZNuR}{2.38fB} \qquad [8]$$

For the experimental unit, the spray pattern was reasonably uniform over a 3-ft length at the surface of the seed band (i.e., Z = 3 ft), and R = 1.45 ft (approximately).

Hence, $$E = 1.83 \frac{Nu}{fB} \qquad [9]$$

Values of N and B may be obtained directly from the operating conditions for each run, but evaluation of u and f for these tests must be done indirectly and involves a considerable amount of estimation. For runs at drum slopes of 0 and 1 deg, we can obtain from intercepts on Fig. 5, a value of u = ⅜ in. As the drum slope is increased, with the resultant decrease in total thickness of seed band, one would expect u to decrease somewhat. Hence, values of 5/16 and ¼ in were assumed for drum slopes of 2 deg and 3 deg, respectively.

The seed slip factor f is defined as (degrees through which drum rotates in time t_1) divided by (θ, which is degrees travel of seed in time t_1). As an aid in evaluating f, calculations were made to determine the angle up from the bottom of the drum at which seed would just start to slip on the relatively flat portion of the surfaces between peaks and valleys of the corrugations. (This surface is at an angle of about 27 deg from a tangent to the drum at that point.) These calculations were based on a force balance involving centrifugal force, friction of the seed on the metal surface, and the force due to gravity. In general they indicated maximum no-slip angles about 10 to 20 deg below the observed upper limits of the seed band. This upper 10 to 20 deg would represent the deceleration zone for the seed. Incidentally, the slippage of seed over the corrugated surface in this region contributes to the self-cleaning action of the drum. If we assume that in the runs listed in Table 2 the seed is carried up through 80 per cent of the band width at drum speed and decelerates uniformly in the upper 20 per cent, then the seed slip factor is $f = (80 + 2 \times 20) \div 100 = 1.20$. In the one 3-deg run the seed band was relatively thin and carried up only to about 95 deg as compared to 100 deg for corresponding runs at 0-2 deg slope. Probably a slip factor somewhat greater than the assumed value of 1.20 should have been used for this run.

The calculated average number of times E that a seed would pass down through the spray zone is included in Table 2 for each run, based on equation [9] and the values of u and f established above. For example, in run 10 the drum speed N was 25 rpm, and the seed rate B was 1.94 bu per min (Table 2). Since this run was at 0 deg drum slope (column 3), a value of ⅜ in will be used for u. A value of $f = 1.20$ was used for all runs in Table 2. Substituting these figures in equation [9] gives $E = 1.83(25 \times 0.375) \div (1.20 \times 1.94) = 7.4$ (see last column in Table 2).

Also presented in Table 2 are figures representing the thickness of the downward-moving portion of the seed band, expressed in terms of number of seeds. The following calculations for run 10 illustrate the procedure used. The average total thickness of seed band was first obtained by using equation [2], which states that $d = 856(M/WLR\theta)$. For run 10 in Table 2, M = 55.5 lb of seed in the drum, θ = 100 deg, and the seed density W was 28 lb per bu. The length of drum L was 6 ft, and the average radius of the seed band for all runs was approximately 1.45 ft. Hence, the total thickness is $d = 856 \times 55.5 \div (28 \times 6 \times 1.45 \times 100) = 1.95$ in. Since the thickness of the upward-moving portion u has been assumed to be ⅜ in for run 10, the thickness of the downward moving portion becomes $1.95 - 0.38 = 1.57$ in. Average seed diameters for the beet seed and for the milo were determined by separation with round-hole screens. The average size was found to be 0.15 in in each case. Considering that adjacent layers of seeds would be nested together in the drum, an average thickness of ⅛ in per layer of seed was assumed. Thus, the thickness of the downward moving portion in terms of number of seeds is $1.57 \div 0.125 = 13$ (see ninth column in Table 2).

The relative values of E and the thickness of the downward moving portion of the seed band, as presented in the last two columns of Table 2, are an indication of expected uniformity of coverage. It should be kept in mind that these figures are only averages and are based on several assumptions and estimations which are perhaps open to question. However, they do indicate trends in regard to the various operating conditions and are useful in predicting performance for other conditions and other kinds of seeds.

SUMMARY

The experimental spray-type treater discussed in this paper has been used to treat decorticated sugar beet seed, milo (grain sorghum), and baby lima beans. With each kind of seed, the most uniform application was obtained when the drum axis was about 2 deg below horizontal. The maximum rate for satisfactory coverage of sugar beet seed was about 3,300 lb per hr. A 2 per cent application of moisture was used in most of the beet seed runs, although a little better uniformity was obtained when the *(Continued on page 527)*

The Engineering Challenge in Spray Application

By O. W. Kromer
MEMBER A.S.A.E.

THE development of selective herbicides for the control of weeds in grain crops has produced a new set of requirements for spray equipment. Experiments conducted in the United States and Canada have fixed the amount of chemical necessary to kill certain weeds under given conditions — also the amount of chemical that can be tolerated by grain crops without affecting their growth, yield, or reproducing properties. It should be fairly simple then to kill any weed in a grain crop in which the amount of chemical required to eradicate the weed is not more than the grain crop will withstand.

For example, to kill ragweed, morning glory, etc., in flax, the amount of 2,4-D needed varies from 1/4 to 1/2 lb of pure acid per acre, depending upon the climatic conditions and upon the growth activity of the plants. This amount of chemical can be applied in 1/2 gal of fuel oil from an airplane traveling 60 mph; or in from 2 1/2 to 100 gal or more of water per acre from a ground spray rig traveling 3 to 10 mph.

It is obvious that applications at the lower gallonages must be made much more accurately than at the higher gallonages in order to achieve the results desired.

It is not quite as simple as this would indicate to get a uniform application of spray material on the plants being treated. The following variables enter into and affect the rate of spray application:

1 Nozzle spray pattern
2 Boom capacity
3 Pressure variations
4 Rate of travel
5 Chemical and water mixtures
6 Wind and climatic conditions
7 Spray swath overlap.

Variations in any one of the above items can be great enough to cause failure of the spray application. Is it any wonder then that there have been failures in weed spraying? The wonder is that there has been as much success with this method of control as there has been. Some discussion of each of the above factors will serve to challenge engineers to obtain solutions to these problems.

The "nozzles" variable is probably as controversial a subject as anyone could pick to talk about; therefore, I will not pose as an expert but inject a few remarks which I feel are pertinent.

The important characteristics of any nozzle are (a) spray pattern, (b) droplet size, (c) uniformity, (d) long life, and (e) non-clogging.

It is apparent that, when nozzles are used in a spray boom adjacent to each other, their spray pattern must be such that it will blend in with the adjoining nozzle to give a uniform application. In order to do this with a nozzle with a narrow spray angle, the spray must be uniform in quantity as determined by catching portions of the spray in test glasses placed in a row along the bottom of the spray fan. The height of the nozzle above the object being sprayed must be such that the lower outer edge of the spray fan will be half way to the next nozzle where it meets the spray from this adjacent nozzle. It is obvious that any change in this nozzle height will cause skip or overdose. Therefore, we do not favor this type spray pattern.

A nozzle with a wide spray angle can be used with a single overlap as shown by the accompanying chart. A perfect spray pattern should be heavy at the center and taper out uniformly. When this nozzle is spraying in conjunction with another nozzle of similar characteristics, a uniform rate of application is obtained and height variations have less effect on the quantity of spray application. The overlap spray will also have greater penetration into dense foliage.

Droplet size is important in that larger droplets are affected less by wind drift and evaporation, although too large droplets may not have as uniform a killing effect as smaller ones.

Uniformity in a nozzle pertains to orifice discharge and spray pattern. It is apparent that all nozzles in a boom should be alike in these characteristics.

Long life in a nozzle pertains to discharge orifice wear and spray pattern change as a result. It is necessary that nozzles maintain their original characteristics for some time so that confidence can be had in the rate of application and spray pattern.

Non-clogging nozzles with poorly designed discharge orifice and unnecessarily fine mesh screen are a constant source of clogging. The nozzle screen should be of ample size, of heavy wire, or of perforated sheet so that it can be cleaned without damage. It should have mesh openings only slightly smaller than the nozzle orifice. There is no advantage in holding back fine particles which plug the nozzle screen when they could as well pass through the orifice. A suitable check valve which will not clog but will remain operative is desirable.

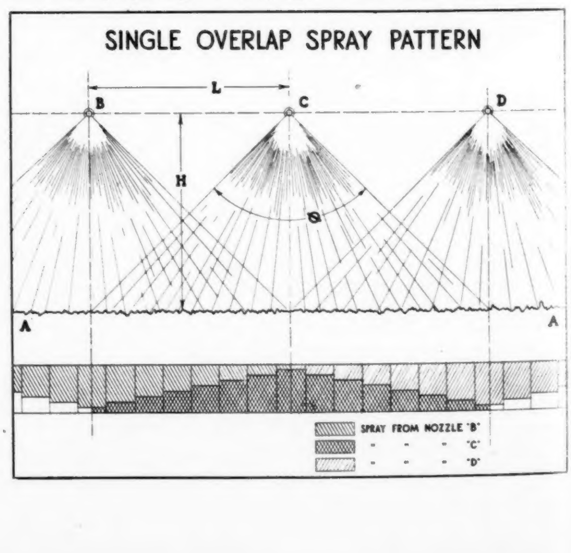
The foregoing requirements apply also to cone-type nozzles, especially when used in spray booms. So much for nozzles and their effect on spray application.

The second variable in spray application is spray boom and delivery hose capacity. This should be sufficient so that the pressure drop within the boom is not excessive and the farthest nozzle from the inlet will deliver its correct output.

The third variable is pressure variations. These are caused by changes in pump speed. A sensitive regulator is necessary to maintain a predetermined pressure constantly on the nozzle orifice.

The fourth variable, rate of travel, may be held fairly constant on level ground with a throttle-governed engine. However, when spraying with a pickup truck or other vehicle with foot-speed control, or in hilly territory with a throttle-governed unit, the speed will vary considerably. This brings out the need for a suitable low-speed speedometer for reading exact ground travel speed and on which, by setting the boom length in the mechanism, the unit would also read acres sprayed.

The fifth variable — variations in chemical and water mixture when preparing for spraying — *(Continued on page 527)*



This paper was presented at the annual meeting of the American Society of Agricultural Engineers at East Lansing, Mich., June, 1949, as a contribution of the Power and Machinery Division.

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A Low-Cost Mechanical Cooler for Holding Cream

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JUNIOR MEMBER A.S.A.E. JUNIOR MEMBER A.S.A.E. MEMBER A.S.A.E.

PREVAILING methods of holding cream on the farm resulted in a product of unsatisfactory quality. The acidity is high, old cream flavors are prevalent, and the quality is generally poor. For a number of years there has been a search for a positive means of maintaining the quality of cream for the period it is held on the farm.

In 1939 a patent (U. S. Pat. No. 2192864) was granted to O. E. Williams for preserving cream with sodium chloride. The addition of salt retarded deterioration and was adaptable to farm use. The U. S. Food and Drug Administration regards the addition of salt to cream as adulteration and has not approved Williams' method. For that reason other means for preserving cream quality must be considered.

Prompt cooling of cream and maintenance of low cream storage temperatures offer an effective means of maintaining cream quality during the holding period.

Factors other than storage temperature affect the quality of cream. The most important of these are length of holding period and cleanliness of cream handling. Low storage temperatures minimize the effects of these other factors. Jensen and Bortree[6]*, in making studies of cream cooling effects, found that the temperature of storage was the most significant factor in controlling cream quality.

Consideration of the means of cooling shows that the only positive method is cooling by a mechanical refrigerator. It offers a means of lowering the temperature quickly and maintaining a low cream temperature throughout the storage period.

Bacterial growth is slow at temperatures lower than 48 F[1]. Temperatures lower than 40 F may cause flavor changes in the fresh cream. Powell[8] reported that raw sweet cream tends to develop a bitter, metallic flavor when held below 40 F.

With this background as a basis it was decided to design a low-cost mechanical cooler especially for holding cream on the farm. This cooler would insure positive temperature control, maintain cream temperatures of 40 to 48 F, and because of its cover it would also offer some protection against air-borne contamination.

Construction. In order to meet performance and low-cost requirements it was decided that the cooler should be of the dry-box type, with automatic controls, space for one 10-gal or four 5-gal cans, and capacity to cool 2 gal of cream in 6 hr from 90 to 50 F, while maintaining cabinet temperature between 40 and 48 F.

Preliminary computations indicated that the cooling load would be 72.5 Btu per hr and the heat leakage and usage load, with usual insulation and two lid openings per day, 131 Btu per hr. It was also calculated that a 1/8-hp hermetic compressor with a static condenser, operating 50 per cent of the elapsed time, would be adequate for the total load of 203.5 Btu per hr.

In addition to the details of construction shown in Figs. 1 and 2, metal to metal contact between coil and inner shell is increased by Thermoplastic No. 446 (manufactured by Prestite Co., St. Louis, Mo.); and air stack increases air flow through the condenser, and the cooler is finished with white baked enamel on the outer shell and aluminum paint on the inner shell.

Test Procedure. Cooling rates for water and for cream were determined, temperature readings being taken by use of copper-constantin thermocouples and a Leeds and Northrup potentiometer. Influences of container size and amounts of cream on the cooling rate were checked.

Data for cost of operation computations were provided by connecting a watthour meter and an electric clock into the compressor motor circuit, between the motor and the thermostatic control switch.

Four four-day preliminary laboratory tests were run with cream. In each test 20 gal of milk were received, sampled for bacterial count, and divided into equal 10-gal portions before separating. The milk was heated to about 95 F immediately before separating. The first portion was handled according to

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This paper was prepared expressly for AGRICULTURAL ENGINEERING.

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AUTHOR'S ACKNOWLEDGMENTS: The authors gratefuly acknowledge the aid given by the faculty and staff of the dairy department, Michigan State College, especially that of Dr. G. M. Trout and J. M. Jensen, who aided materially by offering advice in making quality checks and in scoring the cream each week during the tests. The authors also thank Austin Cunningham, Lansing, Mich., who permitted cooler tests to be run at his farm.

* Superscript numbers refer to the appended bibliography.

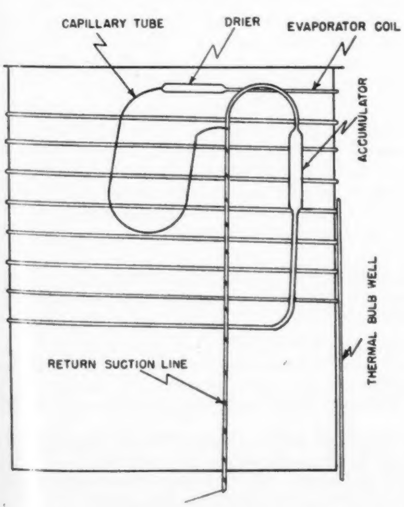

Fig. 1 Coil arrangement for cream cooler

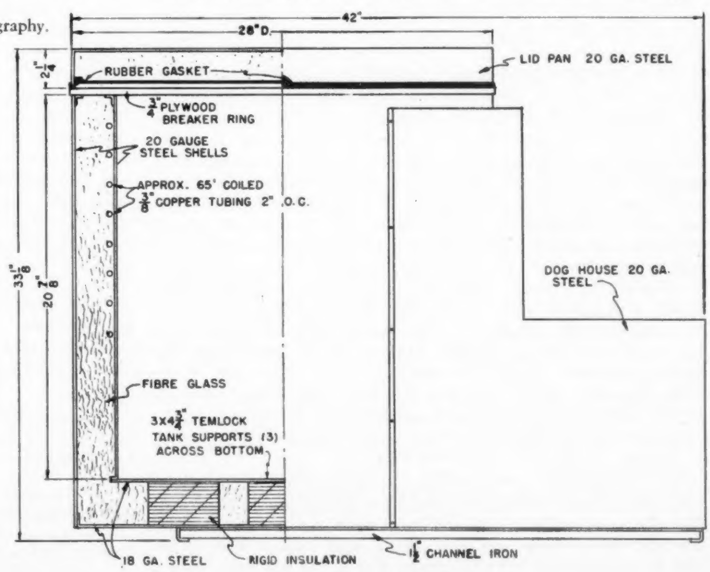

Fig. 2 Details of insulation

a procedure called "A", while the other portion was handled by a different procedure, "B". Under procedure A, the milk was separated and the cream was cooled rapidly to a temperature twenty or more degrees below that of separation. This cooled cream was then placed into the mechanical cooler. The B procedure was the same except that the cream was placed into the cooler at separation temperature. Both procedures were repeated for four consecutive days with the cream added directly to that previously accumulated, with no stirring. Data for the cooling rate, such as weight of cream added and temperatures at various time intervals were recorded during these tests.

In order to determine the effect of cooling on the keeping quality of the cream, both bacterial plate counts and titratable acidities were made each day during the four-day test. The flavor was also scored daily. The score assigned was based on the score of butter which might reasonably be expected if the cream were to be churned.

To observe the performance under farm conditions the test unit was installed on the farm of one of the Michigan State College cream producers. It was placed in the basement of the farmer's house and set up with a watt-hour meter, timing clock, and a two-bulb recording thermometer. Four new shot cans were provided as cream storage containers.

The producer's procedure for handling cream had been to separate the fresh, warm milk, cool the cream obtained to 65 to 70 F, and add this to previously accumulated cream in a 10-gal can. No further cooling was provided, so the cream storage temperature became that of the basement room. The cream was marketed each Saturday.

The cream separator was taken apart and washed after the morning separation. It was rinsed but not dismantled after the evening separation.

For the test with the cooler, cream was added to the shot cans directly from the separator and then placed into the cooler. Succeeding additions were made by removing the can from the cooler, separating onto the accumulated cream and replacing the can into the cooler. When the cream was delivered to the college creamery, it was sampled for acidity and scored for flavor. The receiving temperature was recorded.

DATA AND RESULTS

The preliminary tests with water showed that with 5-gal cans the cooling rate was 3.38 F per hr and with 10-gal cans, 2.53 F per hr. Both the type of can and the total amount of water affected the cooling rate.

The cooling rate for cream was higher, as might be expected, because of the lower specific heat of cream. With cream from the B series the cooling rate on the first day and during the first four hours was as much as 6.25 F per hr. Peaks of temperature for each succeeding day were caused by the addition of new cream to that already in the cooler.

Quality of Stored Cream. The milk separated was of average to poor quality. It is emphasized that A and B cream was from the same milk. It is significant that when the initial bacterial load was very high the B series developed a much higher acidity than the A, but when milk of high quality was used, the difference in developed acidity between A and B methods was slight. The rate of acidity increase is faster for both series when low quality cream is cooled. The results seem to indicate that freshly produced cream may be added to the cooler with no criticism on an acid-development basis.

A few of the samples of very low acidity after four days holding had slightly metallic flavors. This agrees with the findings of Powell[8] as stated earlier.

Butter made from cream of the four tests scored from 90 to 93. With so few samples no definite trend was indicated.

Farm tests were made over the period from July 12, 1947, to August 14, 1948.

For comparison, cream from the evening milkings (clean separator) from Wednesday through Friday was stored outside the mechanical cooler as had been the farmer's usual practice. In no case was the cream held longer than 90 hr. The average acidity for this cream was 0.576 per cent, with a range of 0.52 to 0.56 per cent. The score averaged 89.

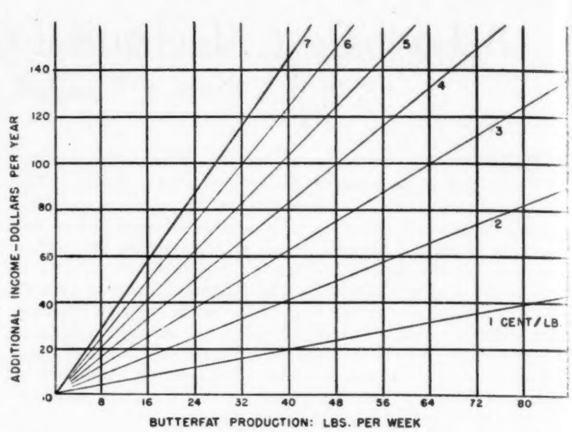

Fig. 3 Additional income from premiums of various amounts for quality cream

Results for the farm-held cream (score range, 90-93) indicate that the mechanical cooler is successful in maintaining the quality of the cream.

The cost of operation depends upon the local cost of power and the upkeep on the cooler unit. Meter readings were made every two weeks during the test period. The average energy consumption was 3.3 kw-hr per week. The range was from 3 to 3.5 kw-hr per week.

After a year's operation there was no breakdown in any of the parts, the insulation was in good condition and all controls operated properly. An accurate estimate of the useful life of the refrigerator cannot be made from the data available at the time of this writing.

The temperature maintained in the cooler was fairly constant, with rises twice daily at the times the cooler was opened for the addition of fresh, warm cream. Fig. 5 is a typical temperature curve plotted from the two-bulb recording thermometer chart.

DISCUSSION

Results on the quality of cream stored indicate that low temperatures for storage are important in the maintenance of good quality. The mechanical cooler offers a means for maintaining a constant low temperature and provides a relatively dust-free storage box.

The design of the cooler is such that manufacturing costs are kept to a minimum. Operation costs are low because of the low energy consumption. Assuming a capital investment of $100 and a life of fifteen years, the annual operation costs are (1) depreciation and maintenance at 10 per cent, $10 per year; (2) average interest cost at 6 per cent, $3.30; (3) cost of energy (½ kw-hr per day at 2c per kw-hr) $3.65; total, $16.95 per year.

If it were necessary to offer the cream producer some added incentive for buying a mechanical cream cooler, a premium could be paid for producing high-quality cream. This premium might be enough to pay the annual cost of the cooler and allow a small profit for its use. Fig. 3 is a graph which shows the additional income which premiums of various amounts would provide.

The use of a mechanical cream cooler offers a positive means of maintaining low holding temperatures and maintaining quality in cream.

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Spray-Type Seed Treater

(Continued from page 523)

same amounts of fungicide and dye were applied with 4 per cent moisture. In treating milo, the only seed rate tried was 6,300 lb per hr, using a 1 per cent moisture application. With baby limas, trials were made with ½ per cent moisture added at a seed rate of 8,100 lb per hr and with ¼ per cent at 11,000 lb per hr. Satisfactory coverage was obtained in each case, with no mechanical injury to the seed.

Nozzle pressures from 25 to 60 psi were found to be satisfactory for treating seeds such as sugar beets, on which uniform coverage is difficult to obtain. The lower pressure is more desirable from the operational standpoint, as it allows the use of a larger nozzle and thus reduces the tendency to clog. Pressures somewhat less than 25 psi can be used when treating smooth-coated seeds, such as beans, where redistribution from seed to seed contributes to uniform coverage. In general, the uniformity of application obtained with a particular spray pattern, especially on seeds where there is no appreciable redistribution, is affected by the following conditions:

(a) Kind of seed. Small seeds are more difficult to treat than larger ones, because the chances of exposure when passing down through the spray zone are fewer.

(b) Volumetric seed rate. Uniformity of application improves considerably as the seed rate is decreased.

(c) Drum speed. Increasing the drum speed improves uniformity of coverage. However, speeds much above 25 rpm are not desirable with the unit discussed herein, because seed would tend to shower down through the spray, or carry over the top.

(d) Drum slope. Increasing the angle below the horizontal improves uniformity until a slope is reached where the seed band becomes so thin that it is unstable and has excessive slippage on the drum.

The seed treater discussed in this paper is essentially a high-capacity constant rate machine and is not particularly suited to the treatment of small lots of seed. The maximum seed rate is determined by the ability of the machine to apply the treating material uniformly. The minimum seed rate when applying materials suspended in water is determined chiefly by the minimum size of nozzle which can be used without clogging and by the maximum percentage of moisture which can be added to the seed. The principal problems encountered in the use of such a treater are:

(a) Clogging of nozzles and screens by suspended materials. Proper selection of nozzle and screen sizes minimizes this problem. The use of soluble or liquid materials and the improvement of present formulations of insoluble materials would also help.

(b) Abrasive action of suspended materials. Pump troubles have been eliminated by use of a pressurized supply tank with the agitator shaft entering from the top. Erosion of nozzles apparently can be kept within reason by use of stainless steel instead of brass.

(c) Settling of suspended materials in pipe lines. Overcoming this problem requires the use of small-diameter lines to maintain adequate velocities and involves flushing the lines with air or water whenever the machine is shut down.

The chief advantages of this treater are:

(a) Uniform coverage, even on rough absorbent seeds, such as sugar beets.

(b) Protection of the operator from dangerous or obnoxious materials. (The commercial unit now being built will be completely enclosed to confine the treating spray.)

(c) Reduction of dust nuisance in subsequent handling of treated seed (as compared to dusted seed).

(d) Ease of complete emptying and cleaning. The drum is self-cleaning, with no corners in which wet seed might stick and accumulate, and at a 2-deg slope will empty itself within a minute or two after the seed supply is stopped. The seed meter can be emptied completely by merely lowering the hinged flap (Fig. 4).

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Engineering Challenge in Spray Application

(Continued from page 524)

can be caused by inaccurate measuring of the water or chemical and by improper labeling of the chemical. Spray tanks or barrels should be calibrated in 5-gal increments with a good measuring stick. This stick should be used uncoated so the true height of the liquid can be read. Chemical companies are now labeling their cans with the pints of chemical to be used per acre for various crops. This simplifies this part of the application in that it is only necessary to determine the amount of water to be added to the solution, divide by the gallons applied per acre, and add the correct amount of chemical.

A simple diagram or slide rule might further simplify this process especially when the acid content of the can is not labeled as clearly as mentioned above.

Wind and climatic conditions, the sixth variable, have very definite effects on spraying. When spraying under windy conditions, it is advisable to increase the rate of carrier fluid application. This reduces drift and evaporation. Increasing the pressure increases the rate of application only slightly and increases fogging and drift. Therefore, it is necessary to change nozzle tips. A nozzle on which the rate of application could be accurately changed might be desirable.

The final or seventh, variable to overcome is spray swath overlap or skip. This could be eliminated by means of a suitable marker on the extremities of the spray boom. Wheel, skids, etc., are not satisfactory; therefore, it remains for some enterprising engineer to develop a chemical dye or other means of marking the sprayed area.

Items not mentioned above as affecting the rate of spray application, but nevertheless requiring engineering improvement might be mentioned here, such as pumps, tank and booms, hoses and support structure.

The gear pump which is the most popular now in use leaves much to be desired, in that it will not withstand pumping abrasive materials, loses its priming ability when worn, and cannot be repaired. Its redeeming features are cheapness and simplicity. It will stand up well in use if not used with abrasive materials. It should be of ample capacity for high-gallonage spraying.

Tanks and booms should be corrosion resistant to alkalies and acids used in spray materials and fertilizers, and they should be sufficiently strong so as not to break in use.

Hoses should be of ample capacity to carry sufficient chemical for high-gallonage spraying if this becomes necessary and should be resistant to the chemicals and acids encountered. It should have sufficient body and braid to withstand the suctions and pressures imposed.

The support structure should be sufficiently strong to hold the booms rigidly without swaying or jumping while spraying.

When a sprayer is produced with the characteristics mentioned above, the farmer can spray his fields with confidence, knowing that the chemicals will produce the results intended.

A Regional Program for Testing Weed-Control Equipment

By R. A. Norton, V. H. Johnson, and R. E. Larson
MEMBER A.S.A.E. JUNIOR MEMBER A.S.A.E. JUNIOR MEMBER A.S.A.E.

CONTINUED interest in the development and testing of equipment for weed control in growing crops has led to the establishment of a regional research project dealing with the problems encountered in this kind of work. Facilities are available in various states in the Mississippi Valley for the study of equipment problems in corn, sweet corn, soybeans, small grains, sugar beets, cotton, and sugar cane. Preliminary investigations have been started in Minnesota and Iowa on the first four of these crops. This paper will deal only with equipment for the row crops — field corn, sweet corn, and soybeans — and with certain laboratory studies.

Previous Work. A project on methods of controlling weeds has been active for several years at the Agricultural Engineering Research Farm near Ames, Iowa. Before 1948, these attempts were mainly by mechanical methods such as tillage and cultivation. Results obtained from these studies have been reported previously in several publications. Reference will not be made to all of them but the reader's attention is directed to the discussion of tillage by Norton, Collins, and Browning[3]* and Browning and Norton[2] and to the discussion of general methods of controlling weeds by Shedd, Collins, and Davidson[4]. Experimental machines were built especially for the purpose, or machines ordinarily sold by farm equipment dealers were modified to obtain desired results. These machines might be used to treat the soil so as to discourage the germination of weed seed or to uproot or otherwise hinder the development of weeds already growing.

During the period 1936-46 a farm at Lamberton, Minn., was operated jointly by the University of Minnesota, the Minnesota Department of Agriculture, and the U. S. Department of Agriculture in conducting extensive tests on the control of field bindweed by cropping methods, special machinery, and chemicals.

Flame weeding investigations were started at the Minnesota Agricultural Experiment Station in 1947 on an exploratory basis — to become familiar with the types of equipment available and some of their limitations and possibilities. Late in the growing season of the same year a flame weeder was delivered to the Iowa Agricultural Experiment Station. No detailed testing program could be instituted after this machine arrived, but it was used sufficiently to indicate that beneficial results *might* be obtained through its use in a wet year when mechanical cultivation was not very effective.

Interest in the equipment for distribution of weed-killing chemical sprays, such as 2,4-D, developed rapidly in the north-central states during 1947, when, as stated above, the weed problem in row crops was very serious. Failures of some commercial sprayers during operation and uncertainties as to results that might be obtained from their use led to the preliminary studies of design problems reported by Barger et al[1].

By the beginning of 1948, the program of weed-control equipment research at the Minnesota and Iowa Agricultural Experiment Stations had developed to the point where a division of activities might be made. This would prevent overlapping of effort and would utilize the facilities available in these two states to the best possible advantage. Accordingly a regional laboratory for the testing of the parts such as pumps, nozzles, filters, special valves, and the like that make up spraying equipment is being developed in the agricultural engineering building at University Farm, St. Paul, Minn. Detailed studies of flame weeders were conducted at the University of Minnesota agricultural research center near Rosemount. An extensive layout of field test plots for weed-spraying

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1948, as a contribution of the Power and Machinery Division. Authorized for publication as Journal Paper No. J-1617 of the Iowa Agricultural Experiment Station, Project 396. In the files of the University of Minnesota this is Paper No. 2442, Scientific Journal Series. This is a report of a study, certain phases of which were carried on under the Research and Marketing Act of 1946.

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* Superscript numbers refer to the appended bibliography.

AUTHORS' NOTE: The authors are indebted to E. V. Collins, research professor of agricultural engineering, and R. S. Dunham, agronomist at the Iowa and Minnesota Agricultural Experiment Stations, respectively, for their assistance in planning and carrying out the field work incident to these investigations and to E. S. Renoll, agent (junior agricultural engineer), (BPISAE), who assisted with the field work and computation in connection with the studies in Iowa.

Fig. 1 (*Left*) Testing stand for weed-spraying nozzles at the laboratory at University Farm, St. Paul, Minn. The short piece of corrugated metal just above the graduate cylinders may be tilted back to effect an instantaneous cutoff of flow from test rack to cylinders. Excess spray material then drains back to the supply tank through a trough underneath the larger corrugated sheet • Fig. 2 (*Right*) The testing stand for pumps used in chemical spraying for weed control at the Minnesota laboratory. Discharges and pressures developed by each pump may be determined by a common set of instruments while all pumps remain continuously in operation. The water meter (large dial near front of stand) may be read directly to 0.1 gal. Pressures may be varied from 0 to 300 psi absolute

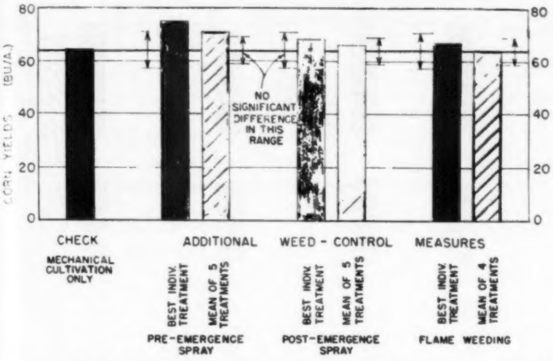

Fig 3. Yields of field corn obtained where various kinds of weed-control equipment were tested at the Agricultural Engineering Research Farm near Ames, Iowa (1948). Heavy black bar, at left, shows yields where only mechanical cultivation was used. Lightweight solid and cross-hatched bars show comparative yields, some significantly higher, where other weed-control measures were added to the mechanical cultivation

equipment, flame weeders, mechanical cultivators, and combinations of two or more of these machines was established at the Agricultural Engineering Research Farm at Ames, Iowa. Here it was possible to study the effects of using different kinds of machines for weed control at different periods during the development of field crops to determine the features that must be built into such machines in the future. Other field tests on varous phases of the weed-control equipment problem were conducted on lands controlled by Iowa State College, but the results are beyond the scope of this paper and will be reported at a later date by other investigators.

Laboratory Studies. Spraying-equipment studies in progress and anticipated for the near future at the laboratory at St. Paul, Minn., include tests of pumps, nozzles, filters, and other components of spraying systems.

The nozzle-testing stand shown in Fig. 1 is similar to that used in the tests reported by Barger et al, cited earlier in this paper. The nozzles are tested at 20-in spacings, the boom height is adjustable, and a shutoff gate is added to allow a determination of the rate of flow through the nozzles. In addition to spray pattern tests, the effect of wear on rates of discharge through the nozzles is being checked by determining the flow during each successive test. Also, the effect of interference of the edges of the fan-shaped spray patterns of adjacent nozzles is being studied where the patterns overlap when nozzles are set exactly in line with the center of the boom.

A test is in progress on the effect of DDT on various metals. Other tests will be started shortly to determine the effect of 2,4-D on metals, implement paints, rubber hose, and rubber tires.

Testing equipment that will accommodate several kinds of pumps in operation at one time is shown in Fig. 2. This provides for checking discharges and pressures of each individual pump with a common set of instruments. The water meter is capable of direct readings as low as 0.1 gal and pressures may be varied from 0 to 300 psi absolute.

Flame Weeding Studies. Based on the preliminary work with flame weeding at the Minnesota Station the previous year, a rather extensive study of this kind of weed control was conducted in 1948. All tests were with field corn. The fuel, liquid petroleum gas, was used in a generator-type burner. Corn yield data were not available at the time this paper was prepared but several recommendations for operation of flame weeders are given as a result of observations made during the growing season:

1 Previous shovel or sweep cultivation that leaves any irregular surface near the row is a definite deterrent to good flaming. Lumps or ridges in the soil tend to deflect the flame and, because the nozzles need to be near the ground surface, may at times nearly block off the mouth of the burner.

2 When working with relatively high discharge pressures with a two-row unit in which liquid petroleum is fed to the generator at the burner, care must be exercised to stagger burners in *adjacent* rows, even though they are discharging in the same direction. The flame of the one may so deplete the air supply to the other that it will go out or burn ineffectually. In other words, the entire path of flame from any burner should be free. The paths of flames from burners working on opposite sides of one row should not interfere lest the flames ricochet when they meet and burn the corn foliage.

3 It is necessary to avoid using such heavy pressures that the flame licks at the leaves of the corn in an adjoining row after glancing upward from the point where it strikes the ground.

4 The generating-type burners used in 1948 proved much more satisfactory than those operating on direct gas pressure from the supply tank, which were used in 1947. Where pressure direct from the supply tank was used, refrigeration due to vaporization within the tank reduced discharge pressure after a few hours' work. This was especially true when the fuel level in the tank had dropped considerably from the "full" mark.

5 The generating-type burner could not be shut down as completely at ends of rows as could the other type. This was due to the fact that the control valve was situated at the outlet from the supply tank and the liquid remaining in the lines leading to the burners provided a large volume of gas, in liquid state, still to be burned after the valve was closed.

6 The generating-type burner has an adjustable air supply valve that requires careful adjustment, but once set it gives good performance.

In addition to the above-described studies, which are of a purely mechanical nature, more basic information on flame weeding is necessary, for example the following: What quantity of heat is necessary to kill weeds? What happens within the plant to cause it to die? What is the comparative efficiency of turbulent, as compared to direct, flame in killing weed growth? What would be the effect on crop plants and weeds of using sooty flames from low-grade fuels rather than almost colorless flames from comparatively high-grade fuels? Some of these problems and many more will, if studied, require the cooperation of workers in plant pathology, perhaps horticulture, biochemistry, and other fields.

Field Plot Studies. Observations and yield data are reported from the field plot investigations at the Agricultural Engineering Research Farm near Ames, Iowa. It is emphasized that these results are for one year only. The weather conditions peculiar to 1948 may have affected the results, and repetition of the same treatments in years with different weather patterns may lead to different conclusions. The findings on the different kinds of row crops and on different varieties of the same crop are sufficiently consistent, however, that a certain amount of confidence may be placed in them.

It is not the purpose, in the following discussion, to compare the effects of different formulations of weed-killing chemicals or different varieties of crops. Varieties were introduced only to show that the general results obtained are not attributable to the accident of selecting a certain variety. For this reason the varieties shall remain nameless. Neither is it intended that the different rates of application of 2,4-D used in some of the series of treatments should, in any sense, be considered as establishing recommended practices. All such variables as rates and dates of application were introduced into the experiment only that the results might serve as a guide to equipment manufacturers and to farm operators who may wish to fabricate their own equipment. Rates of application may affect the quantities of chemical solutions to be carried across the field. This would be reflected in the necessary strength of frames for equipment, size of tires, and the like. The clearance required of various machines depends on the height of the crop at the most desirable time for application. For these reasons the yields are reported by groups, comparisons being made only between the broad categories, such as conventional cultivation, pre-emergence spraying, post-emergence spraying, and flame weeding, except that where height of crop is a factor the treatments that accompanied the best yields will be indicated.

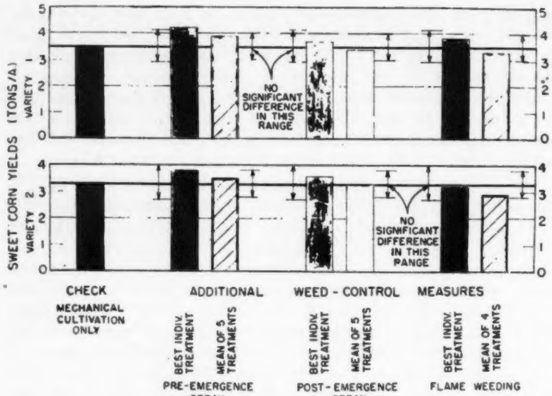

Fig. 4 Yields of sweet corn from plots where various kinds of weed-control equipment were used at the Agricultural Engineering Research Farm near Ames, Iowa (1948). While none of the group-mean yields are significantly larger than where mechanical cultivation was used alone, it is possible, except in flame weeding on variety 2, to select individual weed-control treatments in each category that are on the favorable side of the heavy horizontal lines across the tops of the columns representing yields from the check treatment

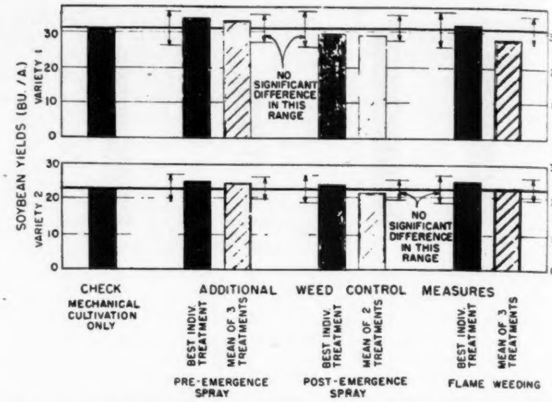

Fig. 5 Yields of soybeans from plots where various kinds of weed-control equipment were under test at the Agricultural Engineering Research Farm near Ames, Iowa (1948). None of the individual or group-mean yields are significantly greater than where mechanical cultivation was used alone. But even with this crop, which is recognized as being susceptible to weed-control measures, it is possible, except in post emergence spraying on variety 1, to select individual treatments in each category where the yields compare favorably with those which received mechanical cultivation only

Pre-emergence sprays of 2,4-D in the form of amine salt solutions were applied to field corn and sweet corn at five different rates, covering the range of recommended practices. These sprays were applied directly to the soil after the corn was planted but before it had come up through the ground surface. Pre-emergence and preplanting sprays were applied to different plots of soybeans. One treatment called for application as long as 4 weeks before planting.

Postemergence sprays of 2,4-D in the form of amine salt solutions were applied at previously recommended rates to these same three crops. For field corn and sweet corn the sprays were put on at various dates from the time the corn had three or four leaves until after the ears were in the milk. Postemergence sprays were applied to soybeans when the plants were 2 in high and, on other plots, when the plants were 12 in high.

A flame weeder, burning propane gas through non-generating burners, was used on different corn plots, once on each plot at four different stages of growth. The same equipment was used on soybeans at two different stages of growth. One group of soybean plots was flame weeded twice during the season. All of these trials were set up for comparison with mechanical cultivation, and the entire group of tests was replicated six to seven times for each crop or variety.

About a week after the crops came up, no difference could be seen between the places where pre-emergence or preplanting sprays had been applied and where there was no treatment. Three weeks after emergence, and at later periods, it was found that such sprays applied at recommended rates (about 2 lb of 2,4-D acid per acre in the amine salt solution form) gave better control of weeds than in other plots. It is to be emphasized, however, that no treatment or combination of treatments held the weeds in check sufficiently to eliminate the need for cultivation.

A comparison of the yields of all three kinds of row crops shows that, where pre-emergence sprays were used, yields were increased over plots where weed control was by mechanical cultivation only. Yield data are presented in Figs. 3, 4, 5 and the least significant differences between yields from different individual treatments and groups of treatments are shown.

All crops and varieties tested, except one variety of soybeans, showed favorable yield results for postemergence spraying. In this category, the best treatment on soybeans seemed to be at a height of 2 in; on sweet corn, at 4 in. On field corn, application after the stalk was full grown seemed to give best results, but there was no serious objection to applying it at 4 in on this crop. The most critical time for application of postemergence sprays to either kind of corn crop was at about 24 to 30 in high, when the plant is growing rapidly. This has been pointed out by many investigators.

All crops and varieties tested, except one variety of sweet corn, responded favorably to flame weeding. The best stage of growth for this treatment seemed to be at about 2 in high for soybeans and at about 12 to 24 in for the corn crops. The corn crops seemed to be most easily damaged by flame weeding when about 4 in high. It seems desirable to pick a comparatively cool, cloudy day, if possible, for flame weeding in corn.

About the most useful conclusions that can be drawn from this study are the following:

1 It may be feasible through pre-emergence spraying, early postemergence spraying, or flame weeding to delay or eliminate the costly and time-consuming first cultivation of corn, sweet corn, and soybeans, waiting for the plants to get large enough to permit tractor cultivators to move rapidly through the field.

2 If corn fields are infested with late-season weeds such as cocklebur and buttonweed, these may be controlled through late spraying with high-clearance machines — the same machines that are used for late-brood spraying for control of European corn borer — without causing any reduction in the crop yield. Again it is emphasized that these conclusions are based on a single year's results and are subject to modification in the light of further investigation.

The foregoing discussion shows how the facilities available at two state experiment stations may be made to supplement each other, but further pooling and utilization of existing facilities are needed. As examples we may cite the desirability of further coordination of the work on weed control equipment for root crops, forage crops, fiber crops, and small grains. The need of further work on flame weeding has been recognized earlier in the paper. Seed-cleaning devices need further testing and development. A start has been made in testing equipment for application of weed-control chemicals by airplanes, but many problems in this category also remain unsolved.

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Milk Cooler Use of Heat Removed from Milk

By R. C. Shipman
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THE purpose of this paper is to present a review of the performance characteristics of various types of can-type farm milk coolers. The data was obtained by testing a number of coolers under laboratory conditions. The procedures outlined in the ASRE Standard Methods of Rating and Testing Complete Can-Type Milk Coolers[1*] were followed. The purpose of the tests was to study the rate of heat removal from the cans under various conditions.

While viewing the rate of cooling under the various conditions which follow, the safe holding temperatures for milk should be kept in mind. Regulations in some localities specify a rate of cooling as fast as 50 F or below within one hour's time. Further emphasis is given to the importance of temperatures below 50 F, especially in the top level of the can, in the report by T. G. Anderson and John E. Nicholas[2] of the Pennsylvania State Agricultural Experiment Station, which states:

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at East Lansing, Mich., June, 1949, as a contribution of the Rural Electric Division.

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"The bacteria in fresh milk is filtered into the cream layer with the creaming of the milk. This phenomenon concentrates 90 per cent or more of the organisms contained in the milk in the cream layer within two hours, depending on its temperature."

In the accompanying temperature curves (Figs. 1 to 8), the can temperatures are given at three points: 3 in from top center, 3 in from bottom center, and midway between top and bottom. The water temperatures are at the top and bottom water levels, or if flowing on the can, the temperature of the water applied to the can.

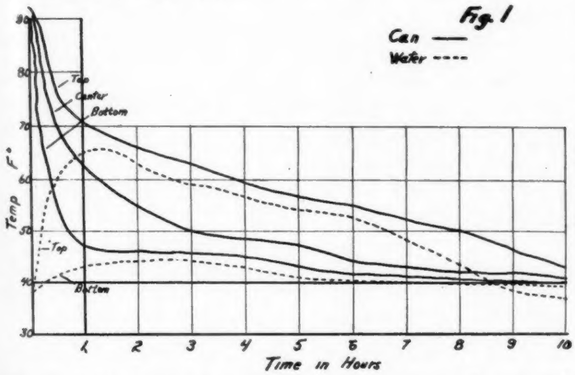
From the preceding, we readily observe the following:

1 Agitation of the water bath assists materially in the movement of heat from the can to the water bath.

2 Agitation of the water bath helps to reduce wide temperature difference between the top and the bottom of the can.

3 The largest amount of heat is removed from the can during the first hour it is in the cooler.

4 If the temperature of the water contacting the can is 40 F or below during the first hour of cooling, the warmest part of the can will be below 50 F within one hour.



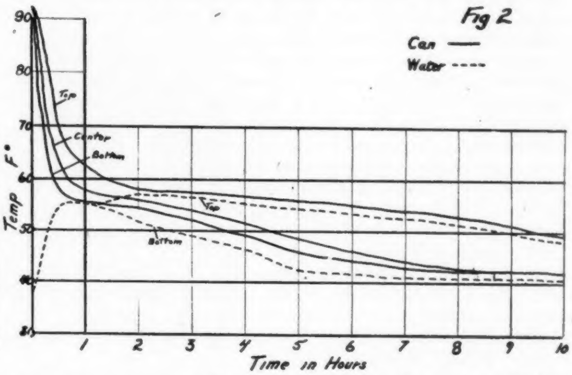
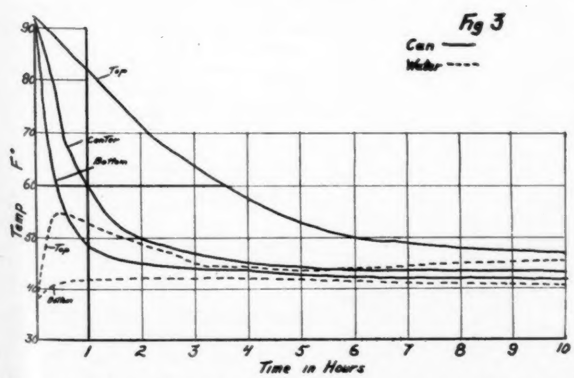


Fig. 1 (*Left*) A water bath cooler with 1.6:1 water-to-milk ratio. Water temperatures at start 39 F. Very small amount of ice and no agitation of water bath. Notice slow rate of cooling of top can level and wide difference in temperature between top and bottom of both water bath and can contents • Fig. 2 (*Right*) Water bath cooler, same as conditions in Fig. 1, except water bath was agitated for one hour. Note less difference between top and bottom can temperatures at end of agitation period



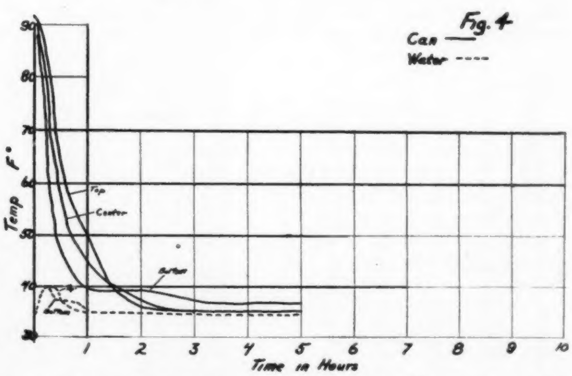
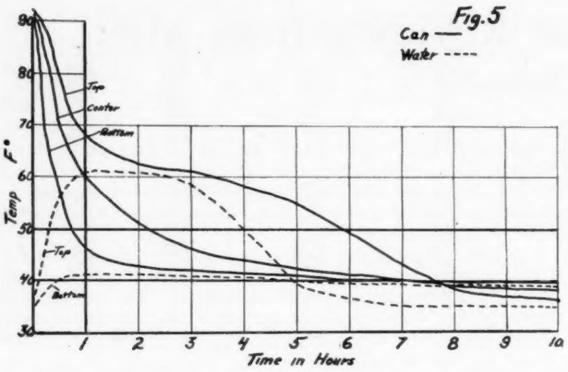


Fig. 3 (*Left*) Water bath cooler, same as Fig. 1, except one-half load of cooler tank capacity in cans put in cooler, without adding water to cooler tank. Low water level causes slow top can level cooling. At the same time water-to-milk ratio was increased from 1.6:1 to 3.2:1 • Fig. 4 (*Right*) Water bath cooler with heavy ice bank, approximately 3.5 lb ice per gallon of milk. Water to milk ratio, 1.9:1. Water-bath agitated 2¾ hr. Ample stored refrigeration and agitation of water bath cool can contents to safe storage temperatures within an hour. The inversion of temperatures of the water (used for test loading) in the can occurred at approximately 1½ hr time. This important phenomenon of stratification of non-agitated water baths is emphasized by John E. Nicholas[3] of the Pennsylvania Agricultural Experiment Station in Bulletin 375. When the average temperature of the water bath is above 39 F, the higher temperatures are in the top layers; however, if the average temperature is below 39 F the top layers have the lower temperatures



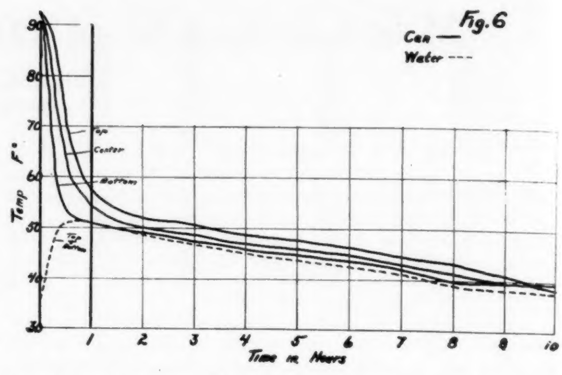


Fig. 5 (*Left*) Same conditions as Fig. 4, except no agitation was made of the water bath. Note the relatively high temperature of top water level for 3½ hr and slow rate of cooling of top can level • Fig. 6 (*Right*) Water bath cooler with 2.2:1 water-to-milk ratio. Water agitated or pumped to spray or flow on bell of can at all times refrigeration unit operates. Water temperature, 35 F at start. Note small difference between top and bottom can temperatures. Rate of heat removal from can after one hour is heat-moving capacity of refrigeration system

5 Only small differences in can temperatures exist in all the types of coolers at the end of a 12-hr period.

The question of cost of operation of the different types of coolers quite often arises. To compare the cost of operation under identical conditions, five 4-can coolers were selected, representing the different types which would give as nearly as possible the same final can temperature at the end of a 12-hr cooling period similar to farm night loading. The final can temperatures ranged from 34 F to 39 F. These coolers were all operated at the same time in the same room maintained at 78 F. A full 4-can load of 92 F water was placed in each cooler for 12 hr. This was removed and a second load placed in for one hour, then removed. It is interesting to note that the running time for the night load on the coolers ranged from 10 hr 30 min for the shortest to 11 hr 55 min for the longest. For the 24-hr loading, the watts per gallon degree temperature drop ranged from 1.9 to 2.3 on the five coolers.

The pattern of cooling of the can during the first hour has little effect on the total running time or current consumed when the cans are in the cooler a 12-hr period. One hour morning cooling uses less current when the amount of heat removed from the can in the hour is less than that removed in a 12-hr storage period.

Of the above coolers, three were powered by ⅓ hp motors and two by ¼ hp motors, yet the total running time and power requirement per degree temperature change was very similar. The refrigerant used in the systems was the same. The differences were in the balance of low and high side pressures. This emphasizes the point that the motor horsepower does not necessarily indicate the heat-moving capacity of the refrigeration unit. For example, a ½-hp high side unit may be powered to operate within a 0 to 25 F evaporator temperature range. At 0 F its capacity is only 2200 Btu per hour, while at 25 F its capacity is 4100 Btu per hour, and at 15 F, 3300 Btu per hr.

Under normal farm loading conditions, approximately 4000 Btu are placed in a cooler in each 10 gal of milk. If the 25 F evaporator temperature is used, this unit could remove the heat from one 10-gal can with approximately one hour's running time, while if a 15-deg temperature is used, approximately 1¼ hr running time would be required, and at an extremely low temperature of 0 F, the running time would be almost 2 hr. This is disregarding any cabinet losses.

Winter and summer operation of milk coolers offer a wide variety of operation conditions. With milkhouse temperatures at 80 F or higher, the refrigeration unit has a heavier load than winter temperature conditions in the milkhouse in the 40-deg range. Cabinet losses are reduced if not almost eliminated. The heat-moving capacity of the high side is increased. Instead of a 10 to 11-hr running time required for summer conditions, only a 6 to 7-hr running time will cool the milk in extreme winter conditions.

From the standpoint of heating the milkhouse in winter, the increase in heat-moving capacity is desirable; however, the heat from the milk load is placed in the milkhouse in a shorter period of time. With a 6 to 7-hr running time, it means that on the evening load heat has been placed in the milkhouse by midnight. At the same time the milk is cooled to the lower temperature in a shorter period of time which is desirable from the standpoint of maintaining quality.

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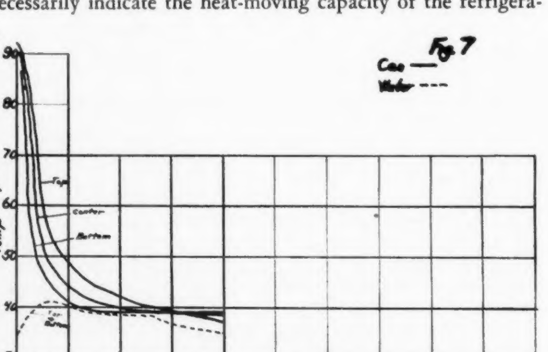

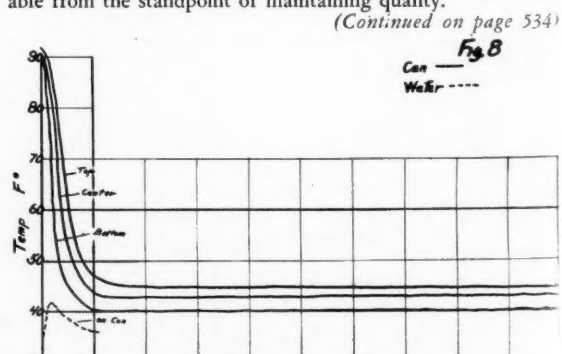

Fig. 7 (*Left*) Same conditions as Fig. 6, except one-half loading of tank capacity of cans put in cooler. Water-to-milk ratio changed from 2.1:1 to 4.2:1. Shows ample stored refrigeration to cool can contents to 50 F within one hour. With water flowing on bell of cans, low water level did not reduce rate of top can level cooling • Fig. 8 (Right) Dry can storage front opening cooler. Water applied to bell of can during cooling period of one hour. Water-to-milk ratio 2:1, with 3.2 lb of ice per gallon of milk available at start. Water applied to can at rate of 3.5 gal per min. Cabinet temperature maintained at 40 to 45 F after cooling period

Application of Concentrate Sprays with a Conventional Speed Sprayer

By Arthur E. Mitchell

THE development of concentrate sprayers to replace the conventional hydraulic machine is of current interest to the fruit industry because the use of concentrate sprays presents a possibility of reducing spray costs and of effecting more rapid and timely applications at critical periods. Reductions in cost may result from less personnel needed to apply the spray materials, from a reduction in the number of spray machines needed to provide adequate protection within an allotted time, and from a reduction in the amount of spray chemicals required to obtain sufficient deposit to protect the plant.

Concentrate sprayers differ considerably in design, such as the machines described by Brann[1]*, by Pratt[2], and by numerous commercial spray machine manufacturers. Many of these machines are still in the experimental stage for their use in applying concentrate sprays for the seasonal protection of tree fruits. Of the many commercial sprayers now being used by fruit growers, the speed sprayer† a large-air-volume, low-wind-velocity aerosol applicator (Fig. 1) appears to be a machine that could be converted readily into a concentrate sprayer.

Accordingly the following experiment was undertaken to test this machine as a concentrate applicator.

Thirty mature Delicious and 22 mature Northern Spy apple trees, located at the Graham Experiment Station of Michigan State College, in the western fruit area of the state, were selected for this study.

The timing of the spray applications and the selection of the spray chemicals used throughout the season were as suggested for Michigan conditions. Spray mixtures of double strength were compared with the conventional dilute sprays. applying the same amount of spray chemicals per application in each treatment. This was accomplished by reducing the quantity of the double-strength mixture used per tree to one-half that amount used of the conventional spray dilution.

A model 29 speed sprayer, a machine suggested for spraying peach, red cherry, plum, and medium-sized apple trees, was nozzled, using regular speed sprayer nozzles (Fig. 2) to apply both the double strength and the conventional dilution sprays. The bank of nozzles on one of the discharge manifolds was designed to deliver 30 gpm of the conventional spray dilution and the bank of nozzles on the other discharge manifold was arranged to discharge 15 gpm. In each case the nozzle arrangement was such that two-thirds of the spray material was delivered into the upper one-third of the tree. The rate of travel of the speed sprayer was calibrated so that 16 to 18 gal of the conventional spray dilution were applied per tree on the Delicious variety through the first cover and 23 to 25 gal per tree beginning with the second cover. The same procedure was used on the Northern Spy variety, so that the trees sprayed with the conventional spray dilution received 18 to 20 gal of spray per tree per application through the second cover, and 25 to 28 gal of spray per tree per application for the remainder of the season. The rate of travel of the speed sprayer was constant for both treatments. Thus the trees sprayed with double-strength spray mixtures automatically received one-half the quantities of sprays of those trees sprayed with the conventional spray dilutions.

The following is a brief outline of the number of spray applications used on the Northern Spy and Delicious apple trees; the materials and quantities of each spray material used per 100 gal of spray conformed with those given in "The Spray Calendar", Michigan State College Extension Bulletin No. 154:

1 Liquid lime sulfur in the green-tip stage
2 Four mild fungicide sprays through calyx
3 Four mild fungicide sprays after calyx, the last applied July 2, 1948
4 Two DDT sprays for first brood codling moth beginning with the third cover
5 Two DN-111 sprays in early July for European red mite and red spider
6 Two lead arsenate zinc-sulfate lime sprays for apple maggot
7 One DDT spray for second brood codling moth applied August 2, 1948
8 One parathion spray for red spider and late codling moth applied September 3, 1948.

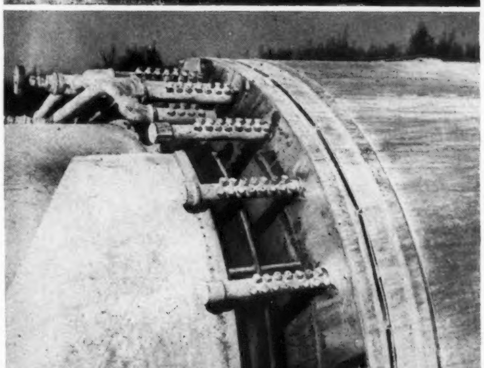

Fig. 1 (*Top*) Model 29 speed sprayer showing the type of discharge pattern used in 1948 to apply the double-strength and dilute spray mixtures • Fig. 2 (*Bottom*) Conventional speed sprayer nozzles used in 1948 on the model 29 sprayer to make the regular diluted and double-strength spray applications, and in 1949 on the model 36 speed sprayer to make the regular diluted spray applications

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at East Lansing, Mich., June, 1949, as a contribution of the Power and Machinery Division. Journal Article No. 1061 (n.s.) of the Michigan Agricultural Experiment Station.

ARTHUR E. MITCHELL is assistant professor of horticulture, Michigan State College, East Lansing.

* Superscript numbers refer to the appended bibliography.

† An aerosol sprayer manufactured by the John Bean Mfg. Co., Division of Food Machinery Corp. Speed sprayer model 29 has a pump capacity of 114 gpm at 50 psi and an airblast capacity of 30,000 cfm at a velocity of 90 mph. Speed sprayer model 36 has a pump capacity of 250 gpm at 50 psi and an airblast capacity of 45,000 cfm at a velocity of 90 mph.

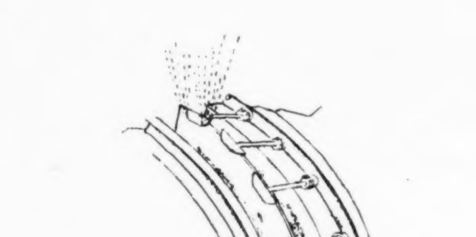

Fig. 3 Speed-mist nozzle used on the model 36 speed sprayer when making double-strength spray applications

A summary of the amount of apple scab and codling moth injury on the fruit harvested in 1948 from the trees included in this test is shown in Tables 1 and 2.

TABLE 1. The per cent of apple scab and codling moth injury on Northern Spy apples harvested from trees sprayed throughout the season with concentrated and regular diluted spray mixtures using a model 29 Speed Sprayer

Treatment	No. of trees	Per cent scab Early	Late	Per cent codling moth Worms	Stings
Concentrate spray*	10	11.8	7.1	3.4	6.2
Conventional spray dilution	12	2.9	4.1	2.0	6.0

* The concentrate spray was double the strength of the conventional spray dilution and only one-half the quantity of spray was used per tree as was used of the conventional spray dilution.

TABLE 2 The per cent of apple scab and codling moth injury on Delicious apples harvested from trees sprayed throughout the season with concentrated and regular diluted spray mixtures using a model 29 speed sprayer

Treatment	No. of trees	Per cent scab Early	Late	Per cent codling moth Worms	Stings
Concentrate spray*	16	5.1	1.3	1.2	1.5
Conventional spray dilution	14	2.9	0.5	0.4	0.4

*The concentrate spray was double the strength of the conventional spray dilution and only one-half the quantity of spray was used per tree as was used of the conventional spray dilution.

It is of interest to note that the amount of apple scab and codling moth injury on the harvested Delicious apples was within the range of commercial control for both the concentrate and the conventional spray applications. This is not true for the Northern Spy. Four trees of this group sprayed with the concentrate mixtures were not pruned in the spring of 1948, and thus were thicker and four to five feet taller (approximately 30 ft) than the other Northern Spy trees in the test. The portion of the crop from these four trees infected with early and late scab was 47, 35, 32, and 16 per cent. The tops of these four trees were beyond the effective operating limits of the model 29 speed sprayer. This experience points out very nicely the necessity of adapting the trees to the spray equipment, if small capacity equipment is to be used effectively.

This study is being continued on the same trees in 1949 using a model 36 speed sprayer equipped with John Bean speed-mist, (Fig. 3) shear-type, non-clogging nozzles, in place of the customary type, to apply the double-strength concentrate materials, and the regular speed sprayer nozzles (Fig. 2) to make the dilute spray application. As this machine has a greater air capacity than the model 29 speed sprayer, the nozzling is designed to discharge the conventional spray dilution at 48 gpm and the double-strength concentrate mixture at 24 gpm. The rate of travel of the speed sprayer is approximately 1.5 mph, so that an average of 14 gpm of dilute spray is applied per tree per application on the Delicious trees and an average of 20 gal on the Northern Spy trees. One-half of these quantities are being used for the double-strength concentrate applications as the rate of speed of the speed sprayer is constant for all treatments. The quantities of spray per tree in all treatments are less than those used in 1948, but the trees were pruned more heavily in 1949 and are more open than they were the previous season.

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1 Brann, James L., Jr. New methods for the application of insecticides to fruit trees. N. Y. State Hort. Soc. Proc. 93:100-106, 1948.

2 Pratt, Robert M. Status of the Cornell Sprayer-Duster. N. Y. State Hort. Soc. Proc. 93:87-93, 1948.

Milk Cooler Use of Heat from Milk

(Continued from page 532)

Weather data indicate that the hours after midnight require as much and generally more heat to maintain desirable milkhouse temperatures during the winter months. Milk company milk volume data indicate that the largest quantities of milk are not produced during the coldest weather. Thus, when the milk cooler has its greatest capacity for cooling, from the standpoint of total running time, the quantity of milk to be cooled is likely to be less.

Additional heat load can be placed in the cooler to increase its operating time. This may be in the form of water. To avoid waste of water it should not be applied at a rate greater than the ability of the refrigeration unit to remove its heat from the cooling tank. The temperature of the cooling water should be at least 40 F or lower at all times. If fast cooling of milk is to be expected, the additional load should be applied in a manner that will not destroy the required amount of stored refrigeration which is required at the time of addition of the milk cooling load. The fast cooling at the time of loading is dependent upon the amount of stored refrigeration and maintaining the temperatures below 40 F of the cooling medium if the temperature at the warmest part of the can is to be below 50 F within one hour's time.

BIBLIOGRAPHY

1 American Society of Refrigeration Engineers, Circular No. 2[illegible]-42.

2 T. G. Anderson and John E. Nicholas, Influence of Cooling Methods on Bacteria of Milk, Bulletin 454, Pennsylvania Agricultural Experiment Station.

3 John E. Nicholas and R. U. Blasingame, Electric Milk Refrigeration at the Farm, Pennsylvania Agricultural Experiment Station, Bulletin 375.

Soybean Economy

IN A resolution adopted at its 29th annual meeting in Minneapolis in September the American Soybean Association urged that soybean farmers forego the benefits of the rigid high governmental support prices extended to the so-called "basic commodities."

As reasons for its recommendation, the association cited the need of a sustained and economical source of edible fats and oils to meet our domestic and foreign needs; the necessity of maintaining in this country adequate supplies of protein feed to supply an expanding grassland livestock production; the dire need for edible vegetable proteins for direct human consumption, and the fact that soybeans are the practical crops adjustment factor in both corn and cotton areas.—*Chemurgic Digest*, October 1949.

Opportunity for the Young Engineer

DEAR JUNIOR AGRICULTURAL ENGINEER:

I REMEMBER with pleasure meeting you at East Lansing, Michigan, and I am honored to have your inquiry.

In our present economy, most young people seek early security through employment at a regular salary, which carries with it vacation privileges, sick leave, retirement, and the like. It is refreshing to know some of our agricultural engineers are interested in self-employment.

May I say at the outset our whole social progress has not been favorable for young agricultural engineers to go out on their own. Equipment is expensive, labor regulations are not favorable for the employer, strike threats are hazards, insurance costs are high, and — worst of all — our income tax laws are not favorable for the development of small, individually owned businesses.

Interest in this sort of thing, however, shows daring planning for the future, an independent spirit, individual initiative, and evidence of courage. The will to do means much in the attainment of success in any line, but it must be a strong attribute to bring success in the area of service in which you express interest. As modern agriculture is now organized, there are many opportunities to undertake the sort of thing you and your colleagues have in mind. The farmer of today requires services he cannot well afford to do himself. I shall try to enumerate a few of these:

1 Pest control operations involving high rates of application at critical periods, such as applications by air equipment. Operations such as the application of herbicides for control of weeds in alfalfa or fungicide applications requiring special types of ground machines, etc. In such cases, two things are involved: (a) skilled operators directed by competent management and (b) the right type of equipment. In both of these areas, the agricultural engineer should enjoy a superior position through technical knowledge and know-how, and familiarity with the latest machinery and methods.

2 Land preparation such as levelling, terracing, clearing, rock removal, drainage installations and the like. This is an active and important area and one in which there still remains a gigantic job to be done.

3 Construction work. More and more farmers are unable to do their own construction work. They not only do not have sufficient time and talent but new materials involve new methods of use. Prefabricated structures are popular because they fill a farm need. Take fencing as an extreme example. A crew with mechanical diggers can set a fence line quickly with excellent neatness and strength in a short time. Likewise, if the crew is skilled, they can do it at less cost. Think of the miles of fence in the United States which need to be built and the greater number of miles of fence which need to be rebuilt and repaired. Think of posts, post treatment, fencing materials, bracing, gates, cattle guards, and you can visualize opportunities. Then, how about steel construction, masonary construction and the like? Countless new structures are needed for cattle, sheep, swine, poultry, farm machinery, farm products, and for the farm family.

4 Food processing is important in agriculture, and the trend in this direction has only started. This involves drying, cooling and refrigeration, freezing, packaging, conveying, pasteurizing, transportation, etc. The farmer wants to improve the over-all quality and quantity of his products and both he and the agricultural engineer who helps him and shows him how to do a better job will profit from this venture.

5 Farm operation. I need not go into this, but the agricultural engineer is needed where volume-quality operations are required.

One or two examples of what two graduate engineers are doing may help you to see the possibilities.

One graduate engineer operates an agricultural service. He has a big line agency and also operates a structural department for prefabricated buildings of his own design. To do this, he had to become a licensed structural and civil engineer as well as an agricultural engineer. His net return is reported above $25,000 per year. He has courage, initiative, foresight, and lots of industry.

The other graduate worked for a salary for a while and then bought a farm. Being an engineer, his talents were in demand as an irrigationist for water application to rice. He refused to work for a salary but asked for a crop percentage as remuneration. He handles or supervises water application on 20,000 to 30,000 acres. This shows self-confidence, initiative, and willingness to accept risks. He is doing well.

Thank you for the opportunity you have afforded me to express my viewpoints. You do have opportunities in self-employment, and I urge you to follow through on your interests, but recognize that high rewards also involve high risks. A real service to mankind can be rendered by such courageous undertakings.

Kind regards.

SENIOR AGRICULTURAL ENGINEER

EDITOR'S NOTE: This is a bona fide answer to an inquiry from a young agricultural engineer.

Agricultural engineers and their families — many of them — will view this famous structure — The White House, home of American presidents — when they attend the 43rd annual meeting of the American Society of Agricultural Engineers in Washington, D. C., June 19 to 21, 1950

NEWS SECTION

A.S.A.E. Winter Meeting Program

CONTINUING growth in the subject matter of agricultural engineering, and in appreciation of its importance to agriculture and the industries serving agriculture is reflected in the program for the Winter Meeting of the American Society of Agricultural Engineers. The meeting will be held in Chicago, at the Stevens Hotel, December 19, 20, and 21.

Programs of the four technical divisions will be the major feature of the meeting. In addition the College Division is scheduled for an evening session, and there will be various committee and small group meetings. Following is brief information on the program, by Divisions:

POWER AND MACHINERY PROGRAM

Tillage will be the general subject of the opening three papers, Monday morning, December 19, starting at 9:00 o'clock, with E. L. Barger, chairman of the Power and Machinery Division, presiding. These contributions will cover Principles of Soil Physics Applied to Tillage Problems, by Dr. G. M. Downing, Iowa State College; Results of Tests of Rotary Plows, by R. L. Cook and F. W. Peikert, reporting on work done at Michigan State College; and Plows Designed for Non-Scouring Soils by A. B. Skromme, Pineapple Research Institute of Hawaii.

In a fourth contribution to this session, S. C. Heth, J. I. Case Co., will discuss A Proposed Standard Short Tongue Farm Wagon.

In the afternoon session, starting at 2:00 p.m., attention will be concentrated on Variable Speed Drives for Farm Machines. Electric, hydraulic and V-belt drives are to be covered. Scheduled contributors to this program are F. L. Kopf, Dynamatic Corp.; Lloyd J. Wolfe, Twin Disc Clutch Co.; Martin Ronning, Minneapolis-Moline; and E. G. Kimmick and W. Q. Roesler, Goodyear Tire and Rubber Co. D. C. Heitshu, past chairman of the Division, will preside.

A variety of subjects are on the docket for the Tuesday morning session, at which E. W. Tanquary, vice-chairman of the Division, will preside. They include A Pneumatic Gun for Elevating Hay, by J. B. Liljedahl, University of Tennessee; Cotton Mechanization in California, by J. P. Fairbanks, University of California; Development of a Sugar Cane Harvester, by R. A. Duncan, Hawaii Sugar Planters Ass'n.; and New Applications of the Ferguson Concept of Farm Machinery Design, by L. H. Skromme, Harry Ferguson, Inc.

A joint session Tuesday afternoon with the Soil and Water Division, on Machinery Requirements for Conservation Practices, is summarized in the Soil and Water section of the program.

A power session Wednesday morning will feature Alcohol-Water Injection for High Compression Tractor and Automobile Engines, by James C. Porter, Max M. Gilbert, Howard A. Lykins, and Richard Wiebe, Motor fuels evaluation division, Northern Regional Research Laboratory, U. S. Department of Agriculture; LP Gas as a Fuel for Farm Power Units, by Geo. E. Larson, Kansas State College; and The John Deere Model R Diesel Tractor, by W. H. Worthington, John Deere Tractor Works. E. L. Barger will preside.

A session on materials will wind up the Power Machinery program on Wednesday afternoon, with E. W. Tanquary again presiding. Its two features will be Malleable Iron, Pearlitic Malleable Iron and Nodular Iron in Farm Machinery, by Hyman Bornstein, Deere & Co.; and Applications of Engineered Rubber in Farm Machinery, by W. T. Keenan, Jr., U. S. Rubber Co.

SOIL AND WATER PROGRAM

Division chairman R. B. Hickok will open the program Monday morning, December 19, at 9:00 a.m. with a session devoted to a variety of subjects. They are Planning Terrace Systems for Least Maintenance, by L. D. Worley, zone engineer, Soil Conservation Service, U. S. Department of Agriculture; Development and Study of the Channel Type Terrace, by A. J. Wotja, University of Wisconsin; Teaching Water Management to County Agents and Farm Leaders, by R. P. Beasley, University of Missouri; and Farm Drainage and Drainage Act in Ontario, by F. L. Ferguson, Ontario Agricultural College.

A symposium on Supplemental Irrigation will open the Monday afternoon session, at which J. L. McKitrick will preside. Scheduled contributors include F. W. Peikert, University of Maine; W. F. Lytle, University of Illinois; R. W. Whitaker, University of Illinois; D. G. Womeldorff, Public Service Co. of Northern Illinois; and John Effa, pumping and irrigation equipment engineer, Chicago, Illinois.

This is to be followed by Technical Aspects of the U.S.D.A. Watershed Program for the Missouri Basin, by L. L. Kelley, Soil Conservation Service; and Fundamentals in Soil Conservation Research, by Dr. M. L. Nichols, Soil Conservation Service.

Mechanical aspects of conservation are to receive special attention on Tuesday. In the morning Machinery Problems in Utilizing Crop Residues for Mulches are to be reviewed, with reports on studies in their respective areas being presented by Geo. B. Nutt, Clemson Agricultural College; J. H. Lillard, Virginia Agricultural Experiment Station; L. L. Harrold, North Appalachian Experimental Watershed, Soil Conservation Service; E. R. Baugh, Purdue University, and L. W. Hurlbut, University of Nebraska.

During the afternoon the soil and water group will join the power and machinery men for further consideration of the subject. Chairman Barger of the Power and Machinery Division will preside. The session will open with G. E. Ryerson, Soil Conservation Service, presenting Machinery Requirements for Mulch Tillage and Other Conservation Practices. Engineering representatives of the farm equipment industry will then report on How Industry Is Meeting Machinery Requirements for Conservation Practices. Scheduled contributors are R. M. Merrill, Deere and Co.; D. H. Daubert, J. I. Case Co.; R. R. Poynor and A. H. Keller, International Harvester Co.; V. B. Coxworth, Massey-Harris Co.; and H. E. Pinches, Harry Ferguson, Inc.

RURAL ELECTRIC PROGRAM

Also opening on Monday morning, December 19, the rural electric group have a session featuring Rural Electrification Research and Special Studies by Electric Operating Companies, by W. J. Rideout, Jr., Edison Electric Institute, discussed by J. P. Schaenzer, Rural Electrification Administration; and Rural Electric Engineering Problems on Demonstration Farms, by Harold H. Beaty, Iowa State College. C. P. Wagner, Chairman of the Rural Electric Division, will preside.

Monday afternoon session features are A Stock Tank for Low Temperature Conditions by Arnold M. Flikke, University of Minnesota; Supplementary Water Heating With Freezer Compressor, by Dr. Andrew Hustrulid and Hajime Ota, University of Minnesota; Heat Exchanger Application in Farm Building Ventilation, by Henry Giese and Amin Aly Ibrahim, Iowa State College; and Attraction Lights in Corn Borer Control, by John G. Taylor, Purdue University. D. E. Wiant, vice-chairman of the Rural Electric Division will be presiding.

Tuesday morning's session will feature The Effect of Temperature on Heat and Moisture Production in Dairy Barns, by H. J. Thompson, U. S. Department of Agriculture and R. E. Stewart, University of Missouri; and Dairy Stable Ventilation Studies with Fans in New York State, by W. T. Millier, Cornell University.

For the balance of the morning the rural electric group will join the farm structures men in a program on farm housing being arranged by the A.S.A.E. Subcommittee on Extension Housing.

In the afternoon the same Subcommittee will provide a special program for the Rural Electric Division.

FARM STRUCTURES PROGRAM

This group will hold its opening session Tuesday morning December 20. At that time it will have a program on farm housing arranged by the A.S.A.E. Subcommittee on Extension Housing, Ruby M. Loper, chairman.

Featured on the Tuesday afternoon program, at which W. V. Hukill, chairman of the Farm Structures Division will preside, will be papers on Stresses in Glued Joints, by Henry Giese and C. E. Hamlin, Iowa State College; Timber Connectors for Farm Structures, by R. H. Gloss, Timber Engr. Co.; Site Welded Construction of Farm Buildings, by F. J. Reynolds, Carnegie-Illinois Steel Corp.; and A Clear-Span Preassembled Farm Building Roof, by J. O. Curtis and R. W. Whitaker, University of Illinois.

Engineering problems of dairy barns are to receive attention Wednesday morning, with T. E. Long, vice-chairman of the Farm Structures Division presiding. Scheduled papers include An Extension Program in Dairy Barn Remodeling, by Donald W. Bates, Cornell University; How Electricity Affects Dairy Barn Design, by C. H. Neitzke, University of Wisconsin; and Barn Cleaners — Their Relationship to Dairy Barn Design, by Murray W. Forth, University of Illinois.

Crop storage is the general field of the final session, Wednesday afternoon, with W. V. Hukill presiding. Contributions will cover Construction and Management Problems in the Shelled Corn Storage Program, by Wallace Ashby, U. S. Depart- (Continued on page 538)

A.S.A.E. Meetings Calendar

December 19 to 21 — WINTER MEETING, Stevens Hotel, Chicago, Illinois

February 9-11 — SOUTHEAST SECTION, Buena Vista Hotel, Biloxi, Miss.

June 19-21 — ANNUAL MEETING, Statler Hotel, Washington, D. C.

NEWS SECTION *(Continued from page 536)*

ment of Agriculture and Dr. H. J. Barre, Purdue University; The Application of Fluidization to Conveying Grain, by A. D. Longhouse, University of West Virginia; Cold Storage of Apples in the Pacific Northwest, by G. F. Sainsbury, U. S. Department of Agriculture; and Cold Storage of Apples in Virginia, by R. L. Givens, U. S. Department of Agriculture.

COLLEGE DIVISION PROGRAM

A special meeting of the College Division has been called for Monday evening by Roy Bainer, chairman. He has arranged a program on which Some New Objectives in Preparing College Men for Industry, will be reported by R. U. Blasingame, Pennsylvania State College, and discussed by E. H. Reed, International Harvester Co. A further feature will be a report on the Animal Shelter Research Conference, by J. R. McCalmont.

Iowa-Illinois Section Program

THE Iowa-Illinois Section of the American Society of Agricultural Engineers, organized last April at Moline, started its first meeting season with a meeting held Saturday, October 9, in the Le Claire Hotel at Moline. There was a registered attendance of 91 ASAE members and friends who attended the meeting to listen to a program of particular interest to engineers of the farm equipment industry, which opened with a paper on the elements of welded design presented by Leon C. Bibber, welding engineer in the research and development division of the Carnegie-Illinois Steel Corp. Mr. Bibber's paper was followed by a paper on low-alloy, high-tensile strength steels by Clarence Altenburger, research engineer, alloy division, Great Lakes Steel Corp.

These two papers preceded a luncheon, and following the luncheon the group was entertained by an illustrated talk on farming in Iran presented by Edwin L. Hansen, of Hansen Bros. Agricultural Engineering Sales and Service at Hillsdale, Illinois. Mr. Hansen who recently spent four months in Iran gave a very interesting account of methods and equipment used in the primitive agriculture of that country and presented some of the possibilities for agricultural engineering in the solution of the country's agricultural problems. During the meeting it was announced that the next meeting of the Section would be held at some date in January to be announced later.

Hawaii Section Organized

MEMBERS of the American Society of Agricultural Engineering in Hawaii officially organized as a Section of the Society at a meeting on the evening of Oct. 5. The meeting was held at the Agricultural Engineering Institute, University of Hawaii, in Honolulu, with 29 members and guests present.

Action toward organization of the Section was started early in the year, with the formation in February of a temporary organization named the Honolulu Agricultural Engineer's Club. Members of this group subsequently petitioned for authority to organize as a section of the Society. This petition was granted during the summer and plans made to complete the organization this fall.

Following approval of by-laws, the Section elected officers. Richard A. Duncan, agricultural engineer, Hawaiian Sugar Planters Association, was elected chairman. V. W. Thalman, soil conservation engineer, Hawaiian Pineapple Company, Ltd., is vice-chairman. Secretary-treasurer is Roy T. Tribble, agricultural engineer, Hawaii Agricultural Experiment Station. Warren Gibson, F. H. Krause, and E. G. McKibben were elected to the nominating committee.

John F. Cykler, Rene Guillou, and Arnold B. Skromme constituted the organization committee.

Preceding the business meeting Mr. Duncan was the featured speaker on a technical program in which he presented an illustrated talk on recent developments in mechanical cane harvesting.

Mr. Tribble reports an active interest in the Section on the part of engineering and business personnel of agricultural enterprises in the Islands, and good prospects for substantial growth of the Section membership.

Pacific Northwest Section Holds Meeting

ASSEMBLED at the Harrison Hot Springs Hotel in British Columbia, October 6, 7, and 8, some 160 members and guests contributed to the success of the annual meeting held by the Pacific Northwest Section of the American Society of Agricultural Engineers.

"Forage Crops" was the central theme of the program. Engineering aspects of the production and handling of forage crops were brought out by a number of papers, including "Irrigation and Drainage for Forage Crops," by Max C. Jensen; "Cultural Practices for Forage Crops," by Alvin G. Law; "Utilization of Forage Crops," by A. J. Wood; "Why Must Silos be Tall?" by Joseph Weston; "Control of Weeds, Insects, and Diseases of Forage Crops," by A. W. Evans; "Grass Silage," and "Forage Storage in Oregon," by Dale E. Kirk.

Section officers for the ensuing year elected and installed at the meeting are chairman, Curtis Edwards, president of Edwards Equipment Co.; first vice-chairman, J. E. Harmond, senior agricultural engineer, U. S. Department of Agriculture; *(Continued on page 540)*

NEWS SECTION *(Continued from page 538)*

second vice-chairman, Clarence J. Hurd, owner, Hurd Farm Electric Supply Co.; third vice-chairman, James W. Martin, head, agricultural engineering department, University of Idaho; fourth vice-chairman and student representative, Leonard Staley, agricultural engineering student, University of British Columbia; and secretary-treasurer, Frank G. Mackaness, agricultural consultant, Portland General Electric Co. Together with past-chairmen J. R. W. Young and Karl O. Kohler, Jr., they constitute the executive committee of the Section. J. B. Rodgers, Clyde Walker, and June Roberts were elected to the nominating committee.

Yakima, Wash., was selected by the Section as the location for its yearly meeting in 1950.

A $15 award was made by the Section to one agricultural engineering student in each of four schools in its area, for the best papers submitted on agricultural engineering subjects. Winners were L. A. Lauderdale, Oregon State College; Zimri Mills, University of Idaho; H. W. Robinson, University of British Columbia, and J. M. Cole, Washington State College.

The Section dinner was well attended. Special entertainment for ladies attending the meeting included teas, card games, a shopping tour to Chilliwack; a boat ride on Harrison Lake; and a swim in the hot mineral pool.

Massachusetts Honors Christian I. Gunness

GUNNESS ENGINEERING LABORATORIES at the University of Massachusetts were dedicated Saturday, October 22, with appropriate ceremonies.

The name of the new laboratories commemorates the services of the late Christian I. Gunness, who initiated and headed work in agricultural engineering at what was then known as Massachusetts Agricultural College from 1914 until his passing in 1946. From 1945 he was also head of its division of engineering. He was a charter member of the American Society of Agricultural Engineers.

In the dedication ceremony, George A. Marston, dean of the school of engineering, presided. Addresses by the Honorable Paul A. Dever, governor of Massachusetts, and by James Y. Scott, president, Van Norman Company, were features of the program. Responses were given for the University by Dr. Ralph A. Van Meter, president; for the faculty by Miner J. Markuson of the agricultural engineering department; and for the students by Richard H. Homewood, president of the student engineering club.

The dedication was a feature of the University's annual homecoming day, and the building was open for inspection. It provides laboratories for work in internal-combustion engines, materials testing, fluid mechanics, heating, air conditioning, refrigeration, electrical circuits, and electrical machinery. In addition it has two classrooms and an instrument shop. It is the first new unit in a planned expansion of the school of engineering. It does not house any facilities of the agricultural engineering department, but its facilities will be used by professional agricultural engineering students in appropriate courses.

Driftmier on ECA Junket

IN RECOGNITION of his leadership in agricultural engineering in the South during the past two decades, R. H. Driftmier, head of the agricultural engineering department, University of Georgia, has been named a consultant to the Economic Cooperation Administration. He will serve as the engineering member of a four-man commission to study peanut, cotton, and rice production in French West Africa.

Professor Driftmier's specific duties will be to recommend to the ECA the kinds and amounts of equipment required for land clearing and for the production, harvesting, processing, and marketing of these crops. He will also advise on irrigation methods.

Professor Driftmier, who is a past-president of the American Society of Agricultural Engineers, will be absent from his regular duties for six or seven weeks, four of which will be spent in the fields of French West Africa and the remainder of the time at ECA headquarters in Paris and Washington.

Personals of A.S.A.E. Members

Wilbur A. Busing, until recently in the service of Harry Ferguson, Inc., is now employed in the farm equipment service division of Montgomery Ward and Company, Chicago.

Albert C. Heine, formerly agricultural engineer and assistant superintendent at the West Central Experiment Station of the University of Minnesota at Morris, Minn., has been appointed superintendent of the agricultural experiment station at the University's 8,000-acre Rosemount Research Center near the Twin Cities.

Martin M. Fogel, who recently completed the requirements for a master's degree in agricultural engineering at the University of Minnesota, has accepted a position as agricultural engineer at South Dakota Agricultural College at Brookings, S. D., where he will serve as an instructor and extension specialist in irrigation.

NEWS SECTION *(Continued from page 540)*

Opportunity for Service in India

To The Editor:

I BELIEVE you have heard something of the work of the Allahabad Agricultural Institute at Allahabad, India. There has been reference in the ASAE Newsletters to our work and to the need for an additional agricultural engineer on our staff. For some unexplained reason there has been almost no response to these appeals.

The Institute is a missionary institution and applicants should understand this and be interested in doing definite missionary and Christian work. It is not a place for one who is primarily interested in foreign travel or sight-seeing, though it is true that these are incidental advantages of the work.

We need an all-around man trained in agricultural engineering with a farm background, preferably on a farm where horses were used. It is desirable that he have an MS degree in agricultural engineering, though an exceptionally well-experienced man with a BS degree, might be used, with an opportunity to take his MS degree during his first furlough. It would be desirable for the man to be able to take college classes in any of the engineering subjects, particularly those requiring agricultural knowledge. In some ways it would be desirable if the person appointed were a single man, but a married man would be definitely considered.

The Institute is run somewhat on the basis of a fellowship and salaries are on the basis of maintenance rather than on a commercial salary basis. Basic salary for a single man is approximately $125 per month. A married man gets twice as much, and there is a graded allowance for children up to five in number and until they graduate from college or reach the age of 21. Rent-free housing is provided. There are certain facilities for medical care and travel expenses, and furloughs with pay are provided. The normal term at present is 5½ years for the first term and 7½ years after that. There is also a pension plan by which there is a reasonable pension or retiring allowance provided upon retirement at 65 to 70 years of age.

While conditions in India are changing rapidly there is ample opportunity for a man to do first-class work here. Missionaries work in close and equal collaboration with Indian colleagues. Candidates should not come unless they are prepared to work, and to work at times under Indian colleagues. However, we have a very fine group of men here at the Institute with whom I have found it easy to work in cordial collaboration.

The agricultural engineering problems in India are somewhat different from the problems of America, but they are urgent, and I believe it is not an exaggeration to say that the very lives of many people will depend on our finding correct solutions to them in the next few years, or at the most two or three decades. I believe there are few opportunities in America which offer an equal challenge or opportunity to do really worth-while and important work.

If you know anyone trained in agricultural engineering who would be interested in this sort of work, I would appreciate it if you would put us in touch with them. Please send a copy of your reply to Dr. A. T. Mosher, care of the Board of Foreign Missions of the Presbyterian Church in the U. S. A., 156 Fifth Avenue, New York 10, New York. Dr. Mosher is the principal of the Institute and a former member of the engineering department. He will be in America from the beginning of September till the middle of December.

Mason Vaugh

Agricultural Engineer
Allahabad Agricultural Institute
Allahabad, U. P., India

New Federal and State Bulletins

"Farm Electrification for Rural Youth." (Division III) Washington Farm Electrification Committee (Pullman). Seven step-by-step lessons including review of work done in Division II; meter reading and cost finding; fuses, circuit breakers, and motor controllers; electric motors for the farm; installing three-way switches; automatic control switches; and making pig brooder, chick brooder, and portable electric motor.

"Equipment for Harvesting Hay and Silage," by William Kalbfleisch. Publication 826, Farmers' Bulletin 158 (September, 1949), Canada Department of Agriculture, Ottawa. This deals with methods and equipment for field and storage operations for making hay and silage under Canadian conditions.

Grade A Dairy Barn for Plant Producer Dairies, by G. L. Nelson, K. R. Ray, and C. V. Phagan. Oklahoma Farm Structures Service. Oklahoma Agricultural Experiment Station (Stillwater, April, 1949). This is Plan No. 1 in a new series of "Oklahoma Farm Fitted" structures plans to be issued as prepared. Folds to bulletin size. Drawings include a perspective cutaway view, floor plan, cross section through milking stall area, and front view of stanchion. A materials estimate and points on construction details are included. Available at 25 cents per copy, or at lower prices on quantity orders.

NEWS FROM ADVERTISERS

New Products and Literature Announced by AGRICULTURAL ENGINEERING Advertisers

Electric Wheel Company, (Quincy Illinois) recently issued a new catalog, number 42, entitled "Electric Disc Wheels." It is a 34-page, 8½ x 11-inch booklet in color, with illustrations, line drawings and specifications on the Company's ball type wheels, open center wheels, standard implement wheels, special implement wheels, tractor type wheels, disks for 38-in demountable rims and variable tread, steel tire disk wheels, brake drums, wheel bolts and wrenches, hub caps and spindle washers, and axles. It also includes indexes to hubs, spindle washers and grease seals, and to wheels by rim size and by numerical listing.

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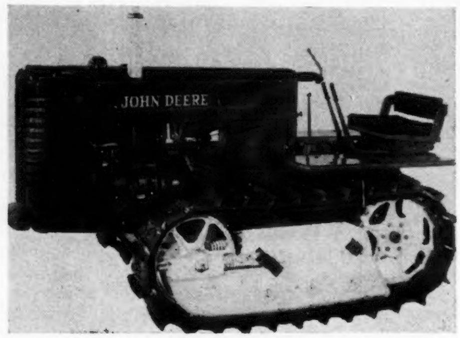
John Deere Model "MC" Track-Type Tractor. First track-type tractor to bear the John Deere name, the "MC" is designed to fill power needs on extremely hilly farms, and in orchards, vineyards, woodlands, muckland, bogland, etc., and in any condition where traction and stability are a problem. The "MC" pulls a 2 or 3-bottom plow, handles an 8-ft double-action disk harrow and similar loads. Engine is the same 2-cylinder engine as in the John Deere Models "M" and "MC" tractors. Electric starting, battery, four forward speeds, adjustable air-cushion seat, power take-off, fenders, sod-pan, fuel filter, oil filter, oil-bath air cleaner, and generator are standard features. Approximate weight is 3875 lb.



The new John Deere "MC" track-type tractor

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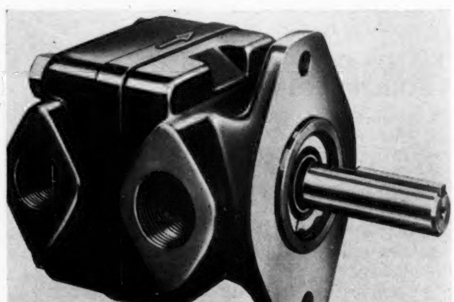
Vickers Hydraulic Pump. A new Series V-200 balanced-vane pump is announced by Vickers Inc., Detroit, Mich. (Write for their Bulletin 49-52.) A major feature of this pump is longer life at maximum efficiency far in excess of fixed-clearance pumps. Not only is normal wear compensated, but the pump also automatically adjusts its clearance to oil viscosity variations resulting from temperature change, so that correct clearances are maintained and more oil is delivered for useful work. The Vickers feature of "hydraulic balance" eliminates bearing loads resulting from pressure. The "vane" principle provides for no-load starting — important in cold weather cranking. Greater mounting adaptability is another feature. The V-200 pump is made in four capacities for operating pressures up to 1000 psi.



Vickers Series V-200 balanced-vane pump

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Atkinson, Harry B. — Hydraulic engineer, Soil Conservation Service, USDA. (Mail) 59 W. Clinton St., Joliet, Ill.

Bisal, Frederick — Agriculture research officer, Department of Agriculture, Soils Research Laboratory, Swift Current, Sask., Canada (Mail) Box 780

Blaising, Mel — Manager of educational and promotion dept., Independent Protection Co., Goshen, Ind. (Mail) 1603 South Main St.

Brown, Everett G. — Regional sales manager, Pacific Coast, New Holland Machine Co. (Mail) 707 Kittredge Bldg., Denver, Colo.

Buchta, H. Glen — Agricultural engineer, Soil Conservation Service, USDA. (Mail) 805 East 5th, McCook, Nebr.

Cocke, J. B. — Agricultural engineer, Bureau of Plant Industry, Soils and Agricultural Engineering, USDA (Mail) Box 413, High Springs, Fla.

Ehlers, Frederick H. — Instructor in vocational agriculture, Emmetsburg Public School, Emmetsburg, Iowa (Mail) 1708 E. 11th

Everett, A. C. — Assistant state supervisor, vocational div., Mississippi State Dept. of Education, Box 771, Jackson 5, Miss.

Fuglie, Chester N. — Agricultural engineer, California Electric Power Co., 3771-8th St., Riverside, Calif.

Grub, Walter — District agricultural engineer, Cornell University. (Mail) Apt. B, 24 Muldowney Circle, Poughkeepsie, N. Y.

Holland, Ed. N., Jr. — Manager, irrigation division, L. R. Nelson Mfg. Co., Peoria, Ill. (Mail) 111 Armstrong Pl. (Zone 5)

Holtan, Heggie N. — Agricultural engineer, Soil Conservation Service, USDA. (Mail) R.R. 1, Box 117, Blacksburg, Va.

Johnson, Waverly L., Jr. — Ranch operator, Box 3128, Westview Station, Waco, Tex.

Keske, Frank E. — Graduate student in agricultural engineering, University of Nebraska, Lincoln, Nebr. (Mail) 1201 West O St.

Kirkpatrick, William M., Jr. — Assistant instructor, California State Polytechnic College, San Luis Obispo, Calif.

Kloepper, Julius W. — Design engineer, John Deere Harvester Works. (Mail) 825-53rd St., Moline, Ill.

Mahoney, George W. A. — Instructor in agricultural engineering, Oklahoma A. & M. College, Stillwater, Okla. (Mail) 912 Carter Ave.

Maierhofer, Chas. R. — Head, drainage engineering div., Bureau of Reclamation, USDI, Denver Federal Center, Denver, Colo.

McCutcheon, George K. — Product research, New Holland Machine Div., The Sperry Corp., New Holland, Pa.

Milne, William — Graduate assistant in agricultural engineering, Michigan State College, East Lansing, Mich. (Mail) 802-C Maple Lane

Moorscroft, Robert — Draughtsman, Harry Ferguson, Ltd. (Mail) 124A, Sovereign Rd., Earldon, Coventry, England

Pendleton, Roger L. — Civil engineer, division of highways, Illinois Dept. of Public Works and Buildings, Ottawa, Ill. (Mail) 702 Congress St.

Randall, William F. G. — Trainee, J. I. Case Co. (Mail) 258 Wallace Ave., Toronto 9, Ont., Canada

Ross, John M. — Agricultural engineer, Dobbins Mfg. Co. (Mail) R.R. 1, Bristol, Ind.

Schleusener, Richard A. — Instructor in agricultural engineering, Kansas State College, Manhattan, Kan. (Mail) 109 N. 17th St.

Schoolcraft, Edwin H. — Research director, Northwest Nut Growers (Mail) Forest Grove, Ore.

Sisson, D. R. — Agricultural engineer, Soil Conservation Service, USDA. (Mail) 715 N. E. First St., Washington, Ind.

Skeirik, Roy M. — 345 E. 18th St., Costa Mesa, Calif.

Southwell, P. H.—Assistant experimental officer, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Bedfordshire, England

Stevens, Myron V. — 721 East 7th Ave., Mitchell, S. D.

Wilcox, J. C. — Assistant superintendent in charge of soil and irrigation investigations, Dominion Experimental Station, Summerland, B. C., Canada

TRANSFER OF GRADE

Schwab, Glenn O. — Instructor in agricultural engineering, Iowa State College, Ames, Iowa (Junior Member to Member)